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PROCEEDINGS OF THE
CONFERENCE ON THE MANAGEMENT OF BIOSPHERE RESERVES

Held at the Sheraton Gatlinburg Hotel
Gatlinburg, Tennessee
November 27-29, 1984

Conference Host:

Great Smoky Mountains National Park Biosphere Reserve

Cosponsors:

UNESCO MAB Secretariat
Canadian National Committee for Man and the Biosphere
United States National Committee for Man and the Biosphere
National Parks and Conservation Association
U.S. Department of the Interior, National Park Service
U.S. Department of Agriculture, Forest Service
The Southern Appalachian Research and Resource Management Cooperative

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National Parks and Conservation Association
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The Southern Appalachian Research and Resource Management Cooperative

In the year prior to the conference, a committee was formed to establish the scope, objectives, and format for the conference and to select the speakers. This committee included William Gregg, Jr., Co-Chairman of the U.S. MAB Project Directorate on Biosphere Reserves; Harold Eidsvik, Chairman, IUCN Commission on National Parks and Protected Areas, and Senior Policy Advisor, Parks Canada; Bernie Lieff, Superintendent, Waterton Lakes National Park Biosphere Reserve (Canada); Donald Brown, Superintendent, Isle Royale National Park Biosphere Reserve (U.S.); Roland Wauer, Assistant Superintendent, Great Smoky Mountains National Park Biosphere Reserve (U.S.); Robert Haraden, Superintendent, Glacier National Park Biosphere Reserve (U.S.); and Paul Pritchard, President, National Parks and Conservation Association. John Peine, Research Director, Uplands Field Research Laboratory, Great Smoky Mountains National Park Biosphere Reserve, served as chairman of the conference and editor of the proceedings. Mr. Wauer coordinated the poster session and audiovisual program. The staff of the Uplands Field Research Laboratory worked behind the scenes to keep things running smoothly. Without the dedicated support and assistance of these agencies, organizations, and individuals, the conference would have not been possible.

CONTENTS

SYNOPSIS OF THE CONFERENCE ON THE MANAGEMENT OF BIOSPHERE RESERVES

John D. Peine[1] and John M. Morehead[2]

The Great Smoky Mountains National Park Biosphere Reserve hosted a conference for the managers of biosphere reserves on November 27-29, 1984. Cosponsors included the UNESCO- MAB Secretariat, the Canadian National Committee for Man and the Biosphere, the United States National Committee for Man and the Biosphere, the National Parks and Conservation Association, the National Park Service (U.S.), the USDA Forest Service and the Southern Appalachian Research and Resource Management Cooperative. A large number of biosphere reserve managers met to discuss the multiple roles of biosphere reserves. Prior to this meeting, the biosphere reserve program had emerged primarily as a scientific initiative; it was time to bring the full spectrum of the program to the attention of the managers of the designated areas.

In general, the managers that came to the conference did not necessarily relate to the biosphere reserve program. When asked, "What is a biosphere reserve?" and "What are its management implications?", more often than not there was an uncomfortable shuffling of feet, a pause in the voice and a perplexed look on the face. Clearly, the program did not have a well-defined and understood image. Strong testament to this was the running joke carried throughout the conference about the Man and the Biosphere (MAB) dedication plaques at the various reserves. Some managers didn't even know where their plaques were. Others indicated that the plaque was the only visible sign of the program. One manager even displayed a rag when he addressed the group, claiming that he used it to keep his plaque polished.

This expressed confusion about the intent and opportunity of the biosphere reserve program was exactly what the conference sought to address. The conference drew an interesting cross-section of participants. Along with representatives from 27 biosphere reserves in North America and six foreign countries, a variety of other interested groups were represented. These included non-profit conservation groups; legislative specialists, teachers, scientists, and news media; and a few private citizens participating in biosphere reserve programs. This mixture of divergent perspectives nourished a productive dialog throughout the conference.

The focus of the program was decidedly and deliberately oriented to the managers of biosphere reserve areas administered by the U.S. National Park Service. Seventy-five percent of the represented reserves are administered by the NPS.

The Biosphere Reserve Concept

William P. Gregg, Jr., Co-Chairman of the U.S. MAB Project Directorate on Biosphere Reserves, defined the concept thoroughly. First, a biosphere reserve is symbolism to "put knowledge and human cooperation to work to build harmonious relationships between people and their environment." A biosphere reserve ideally consists of four

Research Director[1], Uplands Field Research Laboratory, Great Smoky Mountains National Park, Gatlinburg, Tennessee, and Superintendent[2], Everglades National Park, Homestead, Florida

zones; a large core zone of protection for a self-sustaining ecosystem representative of one of the world's 193 biogeographic provinces as defined by UNESCO, a buffer zone with manipulation or experimentation, a zone for restoration, and a fourth stable cultural zone where indigenous people live in harmony with the environment. Gregg capsulated the biosphere reserve management concept as follows: "The watchword is integration . . . integration of functions at the site: monitoring, experimental research, resource management, demonstration, professional training, public education . . . integration to build a model for sustainable conservation of a particular natural region . . . integration of activities at different levels to help solve problems locally, regionally, and internationally . . . integration through cooperation within the management team at each site, between the staffs of nearby sites, between managers and local people, and between professionals in different institutions and countries."

As yet, there are no working examples reflecting the total scope of this ideal perspective, but several exciting efforts associated with various elements of it are underway and were discussed during the conference.

<u>International Perspective</u>

The first day of the conference focused on the international perspective. A provocative address by Harold Eidsvik, Senior Policy Advisor, Parks Canada, set the stage well. Eidsvik traced the evolution of wildland conservation and management from mere designation to internal patrol and a growing active internal management practice. The biosphere reserve marks the beginning of a new era where internal activity is integrated with external influencing factors to provide for a holistic management perspective.

Eidsvik proposed to dispel a myth about biosphere reserves, that they represent a new global network of ecosystem preserves. Most reserves were in fact protected by some other system prior to designation as a biosphere reserve. Eidsvik pointed out that the national park concept has been evolving for over 100 years, while biosphere reserves have evolved only during the past ten years. He then issued a direct challenge to the managers in the audience:

> "America provided the impetus to the global system of national parks. I suggest that in the socio- economic field this leadership is faltering. Many new national parks have been designated around the world, but unfortunately, few of these are effectively managed to achieve conservation objectives. The biosphere reserve is a new management tool which can help to reinforce and ensure the achievement of traditional national park values through increased cooperation of managers and local people. The question is, will America once again accept the challenge and provide leadership in conservation? A system of well selected and managed biosphere reserves is a mechanism for doing so. This is not the 1976 concept of biosphere reserves where 29 reserves consisting only of core areas were created at the stroke of a pen. It is an evolving process, full of challenges."

Richard Bill from the UNESCO Secretariat Division of Ecology and Science in Paris presented an action plan for biosphere reserves, subsequently adopted by the International Coordinating Council of the Program on Man and the Biosphere at its

eighth session in Paris, December 3-8, 1984. This action plan is included in the appendix of this proceedings and is a must reading for all biosphere reserve managers. Arturo Gomez-Pompa, Chairman, MAB-Mexico, provided valuable insights into the UNESCO organization and the global agenda for the MAB program.

The international component of the program was capped with an exciting illustration of the full potential of the biosphere reserve concept. Mike Flemming, Resource Management Specialist, Big Bend National Park, presented Gil Lusk's paper on the potential for an international biosphere reserve incorporating Big Bend National Park and an adjacent portion of the Chihuahuan Desert in Mexico. Flemming pointed out that the idea of an international preserve is not new but has not progressed primarily because it has been broached in the context of becoming a national park in the traditional sense. An exclusionary policy is not compatible with the needs of society in the states of Chihuahua and Coahuila, Mexico. The innovative plans presented for utilizing the biosphere reserve concept to bring the desired conservation ethic to a suitable fruition represents a positive response to Eidsvik's challenge. Perhaps we do have it in us to step out of our conventional agency modes to meet this new challenge!

The United States MAB Program

Bill Gregg eloquently portrayed the spirit and symbolism of MAB, which is probably its single most valuable dimension. He traced the evolution of the program in the United States. Originally, large conservation areas were paired with experimental research sites in the same biogeographic region. Now a systematic selection process is underway to expand and consolidate the network in 25 terrestrial and 13 coastal regions. Presently, the U.S. has 41 of the 273 biosphere reserves located in 65 countries around the world. In the U.S., 22 are administered by the National Park Service and 15 others by the U.S. Forest Service. Gregg discussed a variety of ways that MAB can help managers. The U.S. MAB, for instance, can help foster regional and international cooperation. They can act as a catalyst for conferences and workshops such as this one. They can help make public education programs more relevant to environmental issues. Limited funding is available to act as seed money to promote projects important to MAB, but possibly not in the mainstream of agency priorities. Gregg expressed hope that this funding source may greatly expand in the near future.

Management Activities

The third segment of the first day of the conference focused on tying key management practices to the goals of the biosphere reserve program. Possibly the most important concept to initiate, and probably the most difficult and time-consuming to employ, is the mobilization of regional constituency groups to support biosphere reserve programs. John McCrone, Dean of the School of Arts and Sciences, Western Carolina University, presented a variety of examples of how these linkages have been accomplished at various biosphere reserves. The diversity of approaches is extraordinary. There is no particular best method, other than to capitalize on existing networks relevant to priority biosphere reserve activities.

In order for the group mobilization discussed by McCrone to become a persuasive force, the manager must effectively communicate the relevant MAB messages. Gabriel Cherem, President, Interp Central, Inc. presented several key concepts for clearly communicating conservation values. He advocated producing a clear identity for

biosphere reserves and suggested various ways to image that identity to target audiences. The image should be provocative and relevant to the individual's own life. He outlined the need for systematic communications planning and introduced a new concept for community-wide communication.

Cherem's talk was given at lunch on the first day and an interesting tool was applied to demonstrate the power of effective communication during that event. Local school children had prepared artwork and poetry on what the biosphere reserves meant to them, and their materials were displayed at the luncheon in the form of placemats. The receivers of the mats sent attached self-addressed postcards back to the children, expressing their appreciation and frequently offering mementos from their home biosphere reserves. This exercise proved to be an impressive display of the power of effective, if unorthodox, communication.

Scientific programs are a central focus of MAB in the U.S. and elsewhere. Jerry Franklin, Director, Forestry Sciences Laboratory, USDA Forest Service, described the special role of research in biosphere reserves. He urged all reserve managers to initiate long-term research and monitoring projects that focus on ecosystem descriptive and process studies. He called for systematic data management, increased field support for scientists and better interaction with other biosphere reserves. Research should provide managers with the information needed to preserve native genetic diversity while allowing long-term resource utilization by man.

Social science has an equally important role in supporting the Man and the Biosphere Program. Communications, environmental education, social behavior, economics, community services, ethnobiology and so on are all vital social science fields that apply to biosphere reserve programs. Almost all of the research performed in biosphere reserves today is in the natural sciences. Much of it focuses on the effects of man on natural ecosystems. Yet science in biosphere reserves has all but ignored people from a social perspective. The seven social scientists who attended the conference, led by Donald R. Field, Senior Social Scientist, Cooperative Park Studies Unit, Oregon State University, all agreed on the need for a more balanced scientific emphasis for the biosphere reserve system to realize its potential for attaining a global conservation ethic.

Roland Wauer, Assistant Superintendent, Resources Management and Science, Great Smoky Mountains National Park, discussed the importance of resource management in biosphere reserves. He defined resource management as any activity related to maintaining or achieving a given ecological condition in accordance to the area's management objectives. He advocated the development of a resource management plan that succinctly presents the resource issues and priorities for action in management, monitoring and research. Adequate information tracking and personal training were also emphasized. Wauer stressed that effective resource management must include strong emphasis in education, training, and demonstration. His presentation provided a good summary of the first day's messages.

Workshops on Management Issues

The following morning, the conference attendees broke into five work groups to discuss the application of the biosphere reserve concept to specific management issues common in North American biosphere reserves. Two co-chairpersons were selected to lead each workshop- a resource specialist with expert knowledge on the issue being discussed and

the manager of a prominent biosphere reserve where the issue is important. The resource specialist first gave a background paper on the issue; then the manager summarized the circumstances of the issue at his biosphere reserve site. Group discussion followed to explore how the MAB program could best be applied to the issue at hand. No standard format was used in conducting the group discussions. An unanticipated occurrence in all the workshop discussions was the inordinate amount of time spent reviewing the various functions of the MAB program and the various land use zones of the biosphere reserve concept. Again, the need to better define the program and image the concept was clearly demonstrated.

Air Pollutants Workshop. Molly Ross, Air and Water Quality Division, National Park Service, gave a thorough overview of the U.S. Clean Air Act and the manager's role in the regulation of air quality, a most complicated topic. Boyd Evison, Superintendent, Sequoia and Kings Canyon National Parks Biosphere Reserve, described the air pollution research program underway at his area. The Sequoia-Kings Canyon research effort stands as an excellent example of how research interests can be coordinated and their effect magnified following the principles espoused by John McCrone.

The workshop discussion focused on expanding the scope of research to a regional and global context due to the biosphere reserve status. The site serves as an important early warning system for adverse pollution effects. Although mentioned as important, the session did not focus on public education. Some suggested that the present strategy at Sequoia--Kings Canyon should incorporate education in order to reflect Gregg and Wauer's call for balance.

Development of Nonrenewable Resources Workshop. Thomas Lucke, Chief, Branch of Water Resources, National Park Service, threw out one of the most intriguing challenges at the conference. Lucke suggested that biosphere reserves, "where mining and preservation coexist, can serve as experiment stations in which processes and procedures can be developed to integrate conservation and development. These concepts could then be exported so that extraction, no matter where it occurred, would actively be accomplished in an environmentally sound manner." A tall order to say the least, but this is what MAB is all about. Robert Haraden, Superintendent, Glacier National Park, followed with a discussion of the situation at the cluster of three biosphere reserves--Glacier National Park, Coram Experimental Forest and Waterton Lakes Biosphere Reserves-- where adjacent strip mining and oil drilling are both pending. These three areas have been recommended for redesignation as the Rocky Mountain International Biosphere Reserve. The issues here are greatly complicated by international dissension, but on the other hand this potential linkage also holds the greatest promise for solution. These biosphere reserves represent the best examples of successful MAB programs in North America; they were so recognized through awards presented at the conference banquet to Bernie Lieff, Superintendent, Waterton Lakes National Park, and Robert Haraden. Lieff has established a Biosphere Reserve Management Committee focusing primarily on the ranching community. Haraden is expanding his coordinative role via a regional committee as well. As Haraden stated, these MAB programs are "new, evolving and managers are still trying to determine how to incorporate them in their existing mandates." This sentiment could easily be expressed about MAB programs at any of the 41 biosphere reserves in North America.

The workshop discussion highlighted the need for education to further the MAB concept. The need to look beyond the core unit boundaries and involve the people living in a zone of cooperation was also emphasized. It was suggested that in order to

develop positive ties with the mining industry, we should find a way to divest the posture of "me-versus-they." The group challenged managers to provide leadership in these uncharted relationships by utilizing the principles of MAB.

Use of Renewable Resources Workshop. Stanley Krugman, Director, Timber Management Research, USDA Forest Service, and Co-Chairman of the US MAB Project Directorate on Biosphere Reserves, was unable to attend the conference. Therefore, no resource presentation was made for this workshop, but his paper is included in the proceedings. Robert Barbee, Superintendent of the Yellowstone National Park Biosphere Reserve, described the Yellowstone situation which includes conflicts outside the Park, such as the mining of thermal resources and the activities of ungulates and predators (grizzly bear). As the conference unfolded, Barbee became aware that many of his actions as a manager were right in line with the intentions of MAB. He was a good MAB program manager and didn't know it! He also saw the advantage of applying the MAB concept to help image the Greater Yellowstone Ecosystem as a vehicle to establish a management/research cooperative with neighboring land managers.

Barbee divided his work group into sub-groups and assigned topics similar to those presented on the first day: research and monitoring, education and training, public involvement, and resource management. This arrangement resulted in a well balanced perspective.

Problem Species Workshop. Michael Ruggiero, Regional Chief Scientist of the National Park Service's Midwest Region, outlined the steps for controlling exotic species through integrated pest management. David Ames, Superintendent, Hawaii Volcanoes National Park Biosphere Reserve, described the extraordinary steps taken in his park to control exotic plant species and eliminate feral ungulates that were recently considered an unsolvable problem. The research and management at Hawaii Volcanoes is closely coordinated and they have initiated some intriguing programs in public education.

The workshop discussion emphasized education and research. How do you image the biosphere reserve concepts? School children were identified as a key target audience. An innovative idea was to construct exclosures off-site so that other land managers could see the adverse effects of feral ungulates.

Visitor Activities Workshop. Donald Field outlined the principles of visitor carrying capacity, from both a social and biological impact perspective. He offered a strategy to make judgments on visitor management to preserve an established carrying capacity standard. Donald Brown, Superintendent, Isle Royale National Park Biosphere Reserve, outlined the steps taken in Isle Royale to monitor visitor use impacts on native fauna and flora. He described how the design of facilities has minimized impact in areas of high user concentration. The policy of closing sections of the park completely where the wolves are active was also discussed. The workshop discussion focused on the monitoring of both biological and social impacts and providing adequate public education. Documentations for this workshop are not included in this proceedings.

Field Trips

After the workshops, the attendees were offered a choice of field trips in the Great Smoky Mountains National Park Biosphere Reserve--to high elevation spruce-fir forest experiencing severe decline, virgin deciduous forests, stream ecosystems, the park's

historic district, and the Uplands Field Research Laboratory, where the research staff discussed and explained the practical benefits of more than two dozen research projects. These field trips were well attended and allowed the participants to compare notes and ask further questions.

Banquet

At the banquet, Paul Pritchard, President of the National Parks and Conservation Association, a non-profit organization, provided a fresh perspective of the MAB program from the "outside looking in." His enthusiasm for the MAB program was infectious.

CONCLUSIONS

On the last morning of the conference, the workshop chairpersons summarized the results of their workshops. At lunch, John Morehead, Superintendent, Everglades National Park, captured the spirit that the conference attendees had shared. Morehead stressed that the existing U.S. biosphere reserve areas are not a good representation of the MAB program. The existing sites, essentially "core areas," need to be expanded; other agencies need to be involved; and--perhaps most important of all--our own on-site employees need to be made aware of the entire biosphere reserve concept and program. Morehead also pointed out that the following themes kept recurring during the formal presentations, workshop discussions, and summary remarks:

1. The MAB Biosphere Reserve Program needs identity and image.

2. Its greatest strength is its symbolism that can be conveyed through education.

3. An NPS agency-wide policy concerning MAB is vitally needed.

4. The research focus needs to be long-term and on an ecosystem level, with well managed data and frequent comparison with other reserves.

5. Preserving genetic diversity should be a high resource management priority.

6. The extent to which traditional agency program functions can be "finessed" to incorporate MAB concepts is best left up to the creativity and motivation of the professional staff at each bisophere reserve.

7. Responsibility for the growth and direction of the MAB Program is squarely on the shoulders of the biosphere reserve managers.

8. The enormous challenge to managers is to provide the progressive zeal to carry the global conservation banner into the 21st century.

Appended to these proceedings are two lists which provide specific ideas for managers of biosphere reserves. Harold Eidsvik offers job elements for managers (page 18) and Bill Gregg provides action statements by various categories (pages 183 to 185).

Overall, the conference resulted in a lot of enthusiasm for the MAB Program. The managers were inspired by the promise it holds. Let's hope some productive seeds were sown so that the next time biosphere reserve managers get together, there will be a lot of stiff competition for the best biosphere reserve manager award!

BIOSPHERE RESERVES IN CONCEPT AND IN PRACTICE

Harold K. Eidsvik[1]

The Great Smoky Mountains National Park Biosphere Reserve illustrates the two key issues that we are here to consider, the management of biosphere reserves and the management of national parks. It is a difficult comparison; in the one case we have 10 years of experience, and in the second, 100 years. In essence, it's something like comparing an acorn and an oak tree.

National parks are into their second century, well established as a social invention. For the first 44 years (1872-1916) they had no central management. Then in 1916 the National Park Service was established.

Biosphere reserves have been with us for eight years--not a long time in the development of a social invention. They grew out of an earlier UNESCO program, "The International Biological Program." This program could be summarized as having too much emphasis on science and not enough on man. From this background, the Man and the Biosphere Program (MAB) was launched by UNESCO in 1972.

How will the biosphere reserve "acorn" look in 2084? Should we be deeply concerned about how biosphere reserves are managed at this stage of their evolution? Are we expecting too much from biosphere reserves? Are they a myth or a reality? I expect that these questions will be addressed, if not answered, in the next few days.

From a global perspective, the Biosphere Reserve program exists in more than 66 countries. Some 266 biosphere reserves have been established (UNESCO, 1983). In some countries such as Austria, Egypt, Kenya, Mexico and Honduras, biosphere reserves are working to achieve conservation where national parks were not effective.

In reality, one global tool to achieve conservation does not exist. We must use many tools; among them are national parks, strict nature sanctuaries and biosphere reserves, to name but three. Of these, the biosphere reserve is the newest administrative tool available to managers. Simply put, *"A biosphere reserve is an internationally designated protected area managed to demonstrate the value of conservation."*

I have been a skeptic about biosphere reserves, but I am becoming less so. I see some signs of success and believe that these examples will grow. As I mentioned earlier, these are in Mexico, Austria, Kenya and Honduras.

In North America, biosphere reserves were imposed upon existing systems from the top down, with little explanation of their purpose or function and little interaction with local communities. To function properly they require local involvement. Without this interaction they will not work. We have traditionally done well with national parks in North America. However, I am not certain that our parks are performing in a dynamic fashion, reflecting new scientific developments in ecosystem management and integrating with society in a social and economic sense. In these aspects we are faltering. Leadership is coming from places such as Kenya, Brazil and South Africa.

[1]Chairman, Commission on National Parks and Protected Areas, and Senior Policy Advisor, Parks Canada

In many developing countries, socioeconomic factors are critical both for the existing protected areas and new areas. Encroaching agricultural developments due to demographic pressures are substantial. It is only when the essential protective function of parks and reserves can be demonstrated and integrated with local economic development that we will ensure their future.

I believe that much remains to be done if biosphere reserves are to take their place as an effective conservation tool.

In Canada, we have taken a "go slow" approach; only one of our 31 national parks is a biosphere reserve and it is operating as a pilot project. The second biosphere reserve in Canada, Mount St. Hillaire, is a university property. As a federal government, we have deliberately moved slowly as we do not wish the biosphere reserve program to be identified as a federal program. Natural resources are an area of provincial jurisdiction in Canada and we wish to establish a direct link between the MAB program and the provinces. Indications are that this is now beginning to work and I hope that we will have the first provincially-declared biosphere reserve in the next year. In addition, we are examining the possibility of this status for an additional national park.

BIOSPHERE RESERVES - THE MYTH AND THE REALITY

There is a lot of mythology surrounding biosphere reserves. As I see it, there are two aspects to the myth. One is that biosphere reserves have created a new global network of protected areas. The second is that biosphere reserves are a unique new method of achieving conservation.

Under UNESCO's designation, "Biosphere Reserves" form a global network of scientifically-oriented protected areas. They are UNESCO's principal network of reserves. Other UNESCO-related designations, such as World Heritage Sites or Wetlands, are linked to international treaty obligations. As entities they have legal standing, whereas the biosphere reserve is still a moral concept. In all three cases the international designation places a responsibility on governments to meet internationally-imposed obligations. These obligations, I would suggest, ensure a higher degree of consideration by governments for conservation values than normally exist on non-internationally designated areas. The choice remains national, but once made there is an imposition of a broader consideration- international values.

Some 82 percent of all biosphere reserves were established on the existing network of national parks (Miller 1983). The reality is simple--there is a global network; however, this network is based on affiliation with other established protected areas. The myth is that biosphere reserves have created a new and unique network. The reality is that biosphere reserves are re-enforcing established conservation areas. However, in some special cases, such as Mexico and Honduras, the biosphere reserves are unique and new.

So, one part of the myth is destroyed. Biosphere reserves are not a unique global system of protected areas. A reality remains, biosphere reserves are UNESCO's designated global system of protected areas. The objective is to have a comprehensive system covering all biogeographic provinces. For global scientific monitoring, this is most desirable.

While biosphere reserves do not represent the only system of protected areas, they do contribute significantly to the planning of a global network. Concepts of biogeographic classification were evolving at the same time biosphere reserves were coming to the forefront. Under the general aegis of UNESCO's MAB program, Dasmann and Udvardy

developed a global classification system based on botanical and zoogeographical principles of realms, biomes and biographic provinces (IUCN 1975). These provide a foundation for assessing the global adequacy of protected area coverage. The system provides the foundation for UNESCO's concern about a "representative system of protected areas" on a global scale, a basis for a global overview. Such a system also provides a foundation for a global monitoring program.

At the sub-global, national, or macro- regional level, subsystems of biogeographical classification provide a scientific foundation for the selection of national parks and related protected areas. There exist for the United States and Canada national park systems plans. Similar systems plans have been developed in the Nordic countries (Pahlsson 1983), in South Africa (Huntley 1982), in New Zealand and in several other countries. These subsystems are essential for determining the effectiveness of national conservation networks. They are too detailed for global purposes.

The scientific work of UNESCO's MAB program has contributed considerably toward defining a global foundation for the selection of protected areas. The production of vegetation and soils maps at a global scale and the work of the U.S. Biosphere Reserve program on selection methodology are examples.

To sum up, the reality is that biosphere reserves belong to a particular group of protected areas given international stature by UNESCO. Secondly, UNESCO has advanced the science of biogeography as a foundation for establishing a representative global network of protected areas.

The second aspect of the myth is that biosphere reserves were a unique new method of achieving conservation. This is not the case, since 82 percent of the biosphere reserves exist over some other previously designated area (Miller 1983). However, the potential is there and we need to build a new reality based on the fact that biosphere reserves emphasize the need for a sound scientific foundation for management. This implies a strong research program. Secondly, they emphasize cooperation through local, regional and international networks. In this way they reinforce existing protected area activities. This was well demonstrated in the 1980 U.S. Study of Threats to the National Parks.

New Directions

About this point in time some of you will say,"That's interesting, but really, what is a biosphere reserve?" Literally tons of papers have been circulated about the subject, and this paper will add more. I am not certain that these papers have either removed the myth or built the reality. So, rather than look at the past on what I call "instant biosphere reserves" (a new label on a national park), I would prefer to look to the future and see if we can build a new reality.

What does the new reality consist of? What does it mean to the manager?

Table 1 is an attempt to outline the differences between biosphere reserves and national parks. In many cases, they are so similar it is difficult to be precise about differences. The table emphasizes areas of relative difference.

Under today's criteria, a biosphere reserve should not exist if it consists only of a core area, such as a national park or a national forest research station. Such a biosphere reserve leads only to more confusion about the role of the reserve compared to the role of the area upon which it has been superimposed. In my view, the U.S. designation of 29

national parks as biosphere reserves in 1976 could be looked upon as an overly enthusiastic response to a new program. Having said that, the national parks still have an important role to play as core areas for biosphere reserves.

Just as the role of the National Park Service has evolved to include recreation areas, urban parks and historic sites, so must the role of the biosphere reserve evolve. Just as the utilitarian role of the national forests have evolved to incorporate wilderness areas without logging, mining and mechanized tourism, so must the role of the biosphere reserve evolve.

Globally, national parks are seen by some developing nations as a form of neocolonialism- an exclusive dedication of resources for an exclusive group in society. The new reality requires a closer linkage of benefits to local people, and for them a greater voice in management. (This must be done for national parks as well as for biosphere reserves.) At the same time, the scientific foundation for conservation and education outreach programs must be reinforced.

TABLE 1

Comparative Data

Biosphere Reserves*	National Parks
• roughly 10 years of age	• more than 100 years of age
• internationally designated	• nationally designated
• part of a global system (biogeographic distribution)	• based on scenic and recreational values
• protection - a moral obligation	• protection - a legal commitment
• no existing management structure	• have existing management structure
• a management philosophy	• a management category
• cooperative approach	• regulatory approach
• emphasis on science, research and education	• emphasis on protection, recreation and education
• link to sustainable use (World Conservation Strategy--core zone equals protection; surrounding lands - integration; 82% relate to other protected areas re core zone (affiliated areas))	• island philosophy - tendency to isolation within fixed boundaries; insular
• local advisory committees	• some local advisory groups
• more complicated to establish	• less complicated to establish
• stewardship and sustainable use	• stewardship
• more extensive monitoring	• less monitoring

**A Biosphere Reserve is an internationally designated protected area managed to demonstrate the values of conservation.*

America provided the impetus to the global system of national parks. I have suggested that in the socioeconomic field this leadership is faltering. Many new national parks have been designated around the world, but unfortunately, few of these are effectively managed to achieve conservation objectives. The biosphere reserve is a new management tool which can help to reinforce and ensure the achievement of traditional national park values through increased cooperation of managers and local people. The question is, will America once again accept the challenge and provide leadership in conservation? A system of well selected and managed biosphere reserves is a mechanism for doing so. This is not the 1976 concept of biosphere reserves, where 29 reserves consisting only of core areas were created at the stroke of a pen (UNESCO, 1983). It is an evolving process, full of challenges.

Today's challenge is, how can we best achieve conservation in this complex world of ours? The World Conservation Strategy provides a useful starting point:

> "Conservation is the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment" (IUCN, 1980).

The key words which need emphasis with respect to biosphere reserves, are that conservation includes preservation, maintenance, sustainable utilization, restoration and enhancement of the natural living environment. As with the "multiple use" principle, all of these activities cannot occur in the same place but they can be coordinated.

There remains a perception that national parks are frozen in time. We have failed to communicate the message that they are a necessity, not a luxury. Linking the management of national parks to the management of surrounding lands through the Biosphere Reserve Program is one way of expanding the image of a national park as a mechanism for delivering more broadly-based conservation or social benefits. The integrity of the park remains intact as the core of a biosphere reserve. The image changes because the park is now linked to a broader concept of conservation which involves adjacent land management.

Many national park managers will say that they already have strong linkages to adjacent landowners and community organizations. I would suggest, however, that most of our national parks are prevented from spending their funds on other than national park lands. Most of our park managers have a "frontier" or internally-oriented management approach. I believe those that do not are the exceptions rather than the rule. I hasten to add that this is still often the case for biosphere reserves, as currently structured. I believe it is easier to bring about innovation with a new concept than it is with a traditional concept.

A second perspective from the World Conservation Strategy lends more emphasis to the role of conservation:

> "Conservation, like development, is for people; while development aims to achieve human goals largely through use of the biosphere, conservation aims to achieve them by ensuring that such use can continue. Conservation's concern for maintenance and sustainability is a rational response to the nature of living resources (renewability and destructibility) and also an ethical imperative, expressed in the belief that 'we have not inherited the earth from our parents, we have borrowed it from our children' " (IUCN, 1980).

The stewardship role expressed in the last sentence has always been explicit in the national park ethic and it remains so with biosphere reserves. Finally, we have three objectives for conservation:

- To maintain essential ecological processes and life support systems.
- To preserve genetic diversity.
- To ensure the sustainable utilization of species and ecosystems (WCS).

The first two objectives have been explicit in the national park ethic. The third, "sustainable utilization," carries connotations beyond those of the national park--it is more applicable to biosphere reserves. It does, however, incorporate the protection of watersheds and the use of the area for tourism and genetic conservation as specialized forms of utilization. It is in this context that the term should be applied to national parks.

There is uncertainty and, for some, fear in bringing about change. But without change there is a danger of becoming obsolete. The Biosphere Reserve Program represents change.

In considering their role in relation to that of national parks, I have taken a brief look at the evolution of national parks over the last 100 years. I have divided this time into four periods which I have called preservation, protection, management and integrated management (Figure 1).

Preservation

In North America the preservation period began with the setting aside of large blocks of wild land in the west, to preserve them from alienation and speculation. Roughly from 1860 to 1911, largely looking after themselves because of their isolation, these areas achieved conservation objectives by designation alone. No great bureaucracy was required to look after them. Some areas are still in this state today: the Greenland National Park and Biosphere Reserves; Ellesmere Island National Park Reserve; large segments of Antarctica, and isolated parts of the Amazonian forest. Such opportunities are becoming less frequent and more effort will be required to designate new areas in the future.

Protection

Second comes the protection period, roughly 1911 to 1960. By protection I mean the need to establish a protective force of wardens or rangers to guard the boundaries and prevent trespass. They prevented the exploitation of wildlife (poaching), rangelands, and timberlands in national parks. The force was primarily concerned with what went on inside the boundary of the protected area. This style of operation is still prevalent in many areas today. Some examples would be the Salonga National Park in Zaire, Wood Buffalo in Canada, Denali in Alaska and Manu in Peru. The rules are pretty basic; the scientific foundation is limited. It works well, provided the area is well buffered and relatively isolated.

Management

In about 1960 several things began to happen. In North America, park visitations had been exploding, Mission 66 was well underway and the Outdoor Recreation Resources Review Commission was underway. In Africa there was a growing acceptance of the need to cull large animal populations in Tsavo and Kruger National Parks (Owens, 1972).

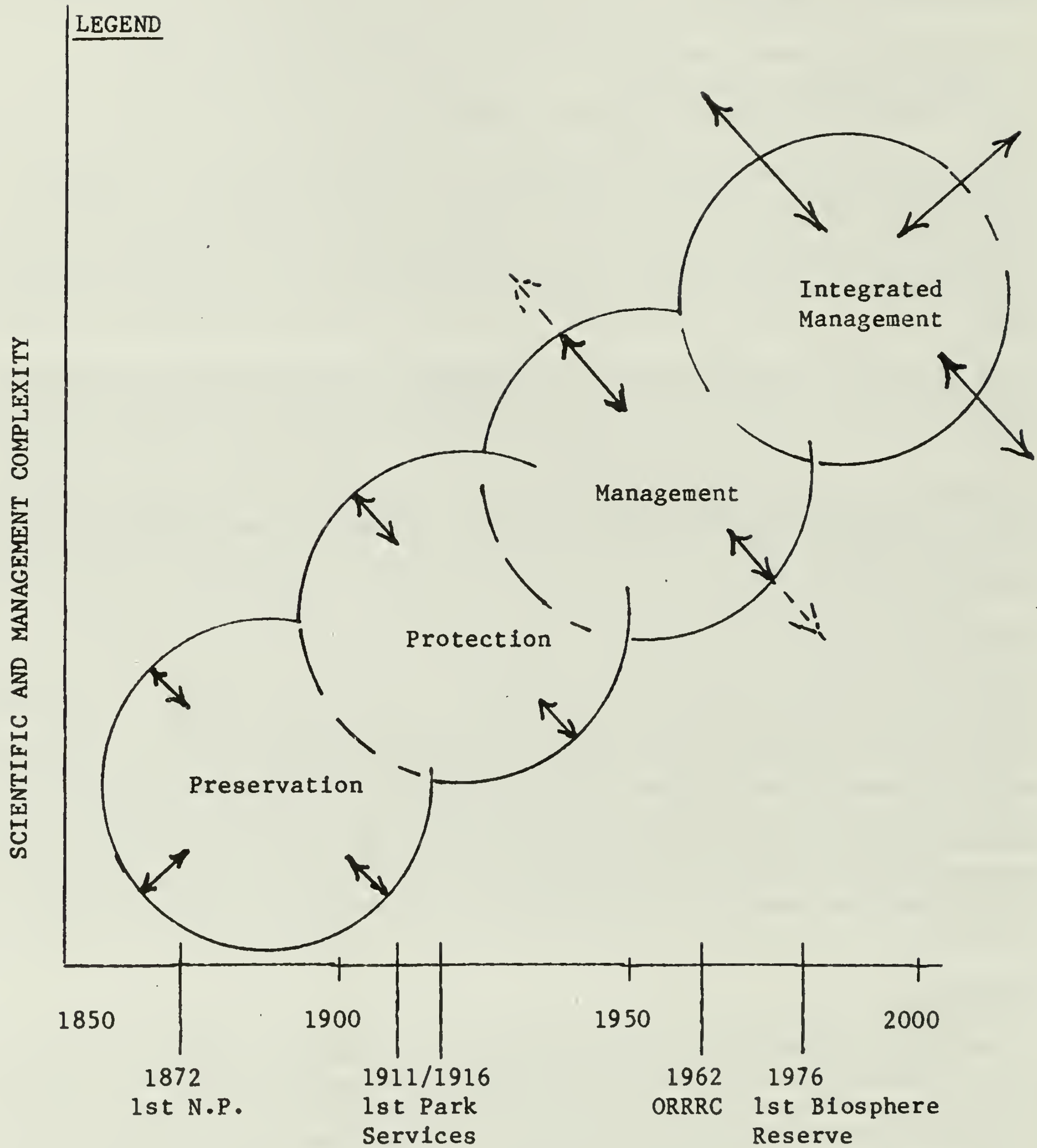

Figure 1. <u>Protected Areas - Evolving Relationships from Isolation to Integration</u>

Zoning as a means of allocating special uses to specific areas was evolving. In essence, laissez-faire management was being challenged as the foundation for the future. Management, however, remained focused on problems inside the fence.

Integrated Management

In most regions of the world, a wholistic view integrating internal and external management issues has not yet arrived. It is perhaps the point at which we find ourselves today. Under the broad philosophy that "no man is an island" we find ourselves faced with a situation in which "our parks are managed as islands." Yet they are islands subject to external threats---air, water, visual or noise pollution, and so on. Some of these threats are imposed, some are controllable, and some are not (hydroelectric power, water pollution, cattle grazing and swidden agriculture). We can no longer be effective managers living in isolation.

If we are to work in an integrated fashion, we must think in an integrated fashion. I suggest that splendid isolation under the preservation and protection concept is no longer an option through which we can achieve conservation. Biosphere reserves can be an important step toward integrated management. For example, biosphere reserves reported "threats three times higher than other parks" (Machlis and Tichnell, 1984). There are perhaps many reasons for this; I would suggest that a concern for integrated management and a greater commitment to scientific research are the main ones.

Without a doubt new directions create uncertainty. What we need is to reduce the uncertainty. Surely with science and technology, combined with an increasing professionalism, we can move toward integrated management. This means a much greater commitment to understanding our natural resource base, where it is today and where it is going. It does not mean a snapshot in time called an inventory. It does mean a continuing monitoring of habitats and species to ensure our heritage will be intact for future generations. Obviously, some of this is being done now in most national parks. In my view it requires reinforcement.

Integrated management means a greater management commitment on lands controlled by national park managers. It also means a greater involvement with respect to lands not controlled by them.

Here the Biosphere Reserve concept comes to the forefront. How do you break down traditional barriers between "us and them," or from another perspective, the parks people and their neighbours? Some may ask, "Why do you need biosphere reserves to do this? As good park managers we do it now." My view on this is that as parks people we tend more to insularity and less to integration.

I would venture to say that in most of our biosphere reserves, there is a realization that some form of international designation exists. Beyond that the myth takes hold and the reality fades. So, what does it mean to the local manager and to conservation in the broader sense? I see a number of points that need touching:

1. There is still a lot of mumbo-jumbo about biosphere reserves. This needs to be reduced. Traditionally, a biosphere reserve required a minimum of four zones:

    a. a core natural zone,
    b. a buffer zone of manipulation or experimentation,
    c. a zone of restoration, and
    d. a stable cultural zone.

The zoning has usually been observed more as the exception than the practice. My colleagues at Waterton Glacier International Peace Park have suggested that what we mean is not zoning but a new form of cooperation; cooperation that is central to making integrated management work.

2. Secondly, within current standards a biosphere reserve cannot exist as a national park alone---alone, in splendid isolation. It needs cooperation and integration with surrounding lands. How to make this work effectively in the long term is the major challenge for biosphere reserve managers.

3. In my particular world, we live in a federal system. It is difficult for the federal park manager to work with provincial organizations without following the protocol of Regional and Headquarters structures. Through broad representation a biosphere reserve management committee can break down these barriers to communication. The biosphere reserve includes federal, provincial/state, and private lands. A biosphere reserve committee provides an open forum for discussion. Similar concepts exist with national parks in New Zealand and France.

4. The biosphere reserve committee also provides a mechanism to review long-term research needs. What are the problems--where are the potential solutions? Is it a question of wildlife moving out of a confining ecosystem onto adjacent agricultural lands? Is it a broader problem, such as insect infestation, which requires shared information? No longer is the Park Superintendent alone or even dominant in the decision process. A cooperative approach is needed, an approach which moves from isolation to integration, an approach which removes some traditional barriers to communications.

5. In a practical sense, if you manage a biosphere reserve, does the responsibility appear in your job description? If not, why not? As a manager you have many responsibilities; the biosphere reserve designation adds a few more. An example of the responsibilities of the Superintendent of a biosphere reserve is appended to the end of this paper. They require him to establish a coordinating committee, to develop research priorities, to solicit funds, to link activities to adjacent biosphere reserves, to communicate activities, to work with adjacent land owners, to organize public events.

In this respect the manager is charged with making the concept work---in essence, to remove the myth and to build the reality.

If we look at the global system of protected areas, the biosphere reserve does hold out some potential. Not as a unique new mechanism but as another arrow in the conservation quiver. Simply, it may work where nothing else does.

In closing, I would again like to move beyond our continental boundaries for a moment. In the lesser developed countries national parks were linked to international tourism. They were seen as the great generators of foreign exchange (Harroy, 1972). In some countries they worked extremely well: Kenya, Tanzania, Uganda are examples.

The national parks were clearly in the national interest. Local people, however, often were subjected to major social and economic disruption. They received few of the benefits and none of the income. They saw the parks as serving an elite, a carry over of colonialism. As population and economic pressures increased, the pressures on the national parks increased.

By linking the national parks to biosphere reserves it is possible to link conservation to sustainable development and to serve the needs of national governments and local people as well. To do this we need new approaches such as biosphere reserves. But even more critical is the need to convince development agencies such as USAID, CIDA, DANIDA and so on that conservation is a part of the development package—the part that sustains the long-term provision of water for agriculture and ensures the continuity of soils, genetic resources and species for future generations. More than ever, the biosphere reserves need to be linked to a funding mechanism, such as the "AID" programs.

In concluding, there is a need to strengthen the Biosphere Reserve Program and to establish a number of model biosphere reserves that can demonstrate how the new wave of conservation works. This will require an attitudinal shift by some members of our constituency. It will require stronger commitments from governments particularly in support of biosphere reserves in developing countries. It will require a shift toward cooperative management in many of the existing biosphere reserves and it will require the disolution of some existing biosphere reserves which cannot meet the existing standards. Finally, there is no doubt that we will need to ensure adequate long-term legal protection for all protected areas.

SUMMARY

In North America there remains considerable skepticism about the potential effectiveness of biosphere reserves on the part of national park managers. To a great extent this exists because 29 national parks were declared as biosphere reserves in 1976 without adequate consultation or consideration of the effect of such a designation.

During the past ten years, the process has begun to mature and the linkage between "core areas" as national parks and adjacent lands is now seen as essential. To change insular managers into integrative managers through cooperative advisory committees is a major challenge for both the park manager and the adjacent land manager.

Biosphere reserves are seen as a new management tool in the conservation quiver. Linkages to the World Conservation Strategy and sustainable development are critical areas to be addressed. The recognition by AID agencies that conservation is a necessity and not a luxury need to be reinforced so that adequate funding can be made available.

Differences between national parks and biosphere reserves are examined. It is clear that even in the existing biosphere reserve/national parks, more attention has been paid to research and scientific monitoring than is the case for national parks alone.

The process of wildland management is examined through four time periods and these are related to concepts of preservation, protection, management and integrated management. It is in the latter direction that biosphere reserve management is moving. It will take time, but the biosphere acorn may yet mature into a mighty oak.

PORTION OF JOB DESCRIPTION FOR A NATIONAL PARK MANAGER RELATING TO BIOSPHERE RESERVE

(Excerpted from a job description for the Superintendent, Waterton Lakes National Park Biosphere Reserve, Canada)

Operate a National Park as an International Biosphere Reserve

Establish a Biosphere Reserve Coordinating Committee consisting of local ranchers, other landowners and park staff with associate members from the academic community, planning commission and other federal and provincial as well as municipal government agencies.

With other Committee members and landowners in general, develop program priorities for the biosphere reserve, including research subjects, requirements for information and demonstration projects. These projects may take place both within the national park and on surrounding lands- -private, provincially, state or federal (USA) controlled.

Solicit funds and expertise with Committee members for the continued operation of biosphere reserve activities not funded by Parks Canada. This includes selling materials as a non-governmental organization and encouraging other agencies to carry out research in the reserve area under their funding programs.

Coordinate reserve activities with adjacent biosphere reserves. A coordinating committee with several members from adjacent reserves has been set up to deal with research proposals involving the different areas of jurisdiction.

Communicate results of biosphere reserve activities to landowners, regional agencies, other biosphere reserves in the world, and the Canadian Office for UNESCO. Press releases are made and the work of the reserve has been featured in newspapers in Montana, Alberta and Maclean's magazine.

As a member of the Committee, work closely with provincial officials in Alberta and British Columbia to include provincial lands in the reserve and to discuss concerns in our mutual boundary areas. Provincial staff in forestry, fish and wildlife and provincial parks are involved with the Committee and attend its meetings to discuss items of mutual concern.

Represent Canada or Parks Canada at training sessions and symposia, both inside and outside Canada, to explain the operation of the biosphere reserve.

Take the leading role in organizing public information events sponsored by the Committee; included are public seminars on subjects of interest to the local ranching community, field trips, bus tours of research facilities and displays on subjects of local concern to be placed at public events such as rodeos and fairs.

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THE BIOLOGICAL RESOURCES OF BIOSPHERE RESERVES

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A park whose flora and fauna are unknown and uncatalogued can be compared to an excellent library whose books have no titles, no authors, and no call numbers.
-- D. Janzen. The Nature Conservancy News 34(1): 24, 1984.

One of the major accomplishments of the MAB Programme of UNESCO has been the creation of a new concept for the conservation of outstanding samples of natural ecosystems with their biota: the biosphere reserves.

The principal outstanding features of this new concept are the following:

1. The inclusion of research activities in the reserves as an essential part of their objectives.

2. The recognition that the biological and ecological scientific community is committed to biosphere reserves as they provide sites for research and for demonstrating its application. It is important to stress the fact that the implementation of the biosphere reserve concept is not only the responsibility of the administrators of the reserves but of the scientific community as well.

3. The inclusion of a "buffer" zone for the development of pilot projects on the management use of ecosystems and their resources.

4. The establishment of an additional "buffer" zone or "area of influence" in which some research application could be demonstrated.

5. The fact that biosphere reserves form part of an international programme which can foster cooperation from many scientists and institutions.

6. The fact that biosphere reserves propose an alternative system and concept for conservation.

7. Man is an important and indispensable component of ecosystems.

Unfortunately, many biosphere reserves, once they have been established, have not developed the originally envisaged activities. For this reason, they have not played the role that they should have had in the international effort to conserve the world's biological heritage.

The first efforts concentrated on establishing the international network. This was done with great success, as there are now 226 biosphere reserves in the international network, and new reserves are proposed each year.

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The effort that many countries have made to create biosphere reserves makes an historical mark in the conservation-development paradigm. It is especially notable that a great number of developing countries have enthusiastically contributed to this effort and with what is most important: ideas.

It seems that the whole movement never passed to the next step of actually putting the concept into practice. It is very badly needed. We have to identify what should be the next step at the local and at the international coordinating level and to try to proceed as effectively as possible.

This was fully recognized at the First International Biosphere Reserve Congress in 1983. The proposed Action Plan mentions the need to look for ways to further implement the biosphere reserve concept.

Considering all these facts, it would appear necessary to design and develop an international research programme that could provide the basic scientific information needed to continue with the original idea of linking conservation, research and development in the biosphere reserve network.

The need is even more urgent in developing countries, which desperately need research on alternative management policies and practices and development plans for the benefit of their rural people that can provide practicable sustainable techniques. Special attention should be made on the available economic and human resources for such a research programme on biosphere reserves.

There is a lack of examples of where biosphere reserves have succeeded in linking conservation, research and development, not only in developing countries but in developed countries as well. The result has been that arguments for such linkages are generally theoretical and often not applicable in the field.

The reasons for this problem are many, and in most cases, these are related to an inadequate knowledge of the resources of the reserves that we are trying to protect. There is also a lack of adequate resource management plans, and above all, a lack of good demonstration projects in developing countries.

For the developing countries, all these problems can be traced back to the basic problem of the lack of a strong scientific community. This is further reflected in the research projects to be carried out in biosphere reserves and in the priority themes of such research.

For these reasons, MAB is promoting a research programme for biosphere reserves that will provide the basic scientific foundation for ecologically sound conservation and development.

In order to better understand the importance of the proposed international programme, we must return to the initial reasons for having biosphere reserves and other protected areas.

We all agree that the main objective is to preserve representative samples of the ecological and biological diversity of the earth in an effort to conserve the biological heritage of future generations that may need new options for their survival, even as we may do.

The most important and well-known arguments for this objective are the following:

a) To safeguard a good representative sample of the diversity of biological and genetic resources which may have a potential for future uses as research advances (e.g. for future drugs, foods, raw materials, species or genes for biological control of pests, etc.).

b) They function as reservoirs of genetic resources for the future improvement of our domestic crops and animals, through the protection of populations of wild relatives.

c) To preserve a biological bank from which we can draw in the future to restore or improve our ecosystems.

d) To preserve ecosystems as an ecological information bank to which we can go back to understand the function of the whole natural ecosystem and of its parts, as a means of improving the management of man-made ecosystems.

If these arguments are still valid, and I believe that they are even more so today, the logical step in research should be to identify both the present and potential biological resources found within the network of biosphere reserves. This is needed not only for the purpose of evaluating what we have, but also to be sure that we are protecting a significant portion of our biological heritage.

It is also important that we develop an international information system on these resources, which would be available to scientists, decision makers, planners, etc. This will help promote research on new and better uses of the biological resources of the world.

These types of research, no matter how logical and worthy they may seem, are difficult to implement as they are linked to a poor knowledge of the biota of many important ecological zones of the earth. This is particularly true in the tropics. Another factor complicating this research is the scarcity of well-trained scientists and professionals in these fields for doing the work in the most needed area.

The paradox of all this is that we are protecting resources that in many cases have not even been identified. According to the National Academy of Sciences of the USA, the tropical biota includes an estimated 5 million species, from which half are unknown to science. There are only about 1500 scientists to study these resources-- is an extremely low figure, considering the task ahead.

This subject has been stressed as a priority subject by a great number of high level panels and scientific reports. It was also identified as one of the original priority themes for MAB.

UNESCO has played some role in this problem, not only through activities of the MAB programme, but also by sponsoring several projects and committees such as the Flora Neotropica and several high-level symposia on the humid tropics.

As a UNESCO consultant, I proposed to MAB a research programme which will hopefully gain the approval of many scientists and countries. This project was approved by the ICC Council of MAB in December 1984, one week after the presentation of this paper in Gatlinburg, Tennessee. The program has the following general objectives:

1) To stimulate MAB National Committee to initiate (at their own expense), concrete research projects on the biological resources of their most important biosphere reserves.

2) To promote multinational pilot and demonstration research projects to study the biological resources protected in biosphere reserves.

3) To develop a global information system on the biological resources of the biosphere reserves that will include scientific names, vernacular names, and minimal biological and ecological information for each species and their distribution.

4) To promote and stimulate research on both the traditional and modern uses of biological resources, particularly in tropical cultures.

5) To promote a global computerized checklist of plants and animals of the biosphere reserves.

6) To promote the dissemination of information on the results of this research to the interested public.

7) To promote the training of new scientists and professionals in these fields, particularly those in developing countries.

8) To promote the participation of leading scientific research centers as advisors and contributors to specific multinational pilot projects in biosphere reserves.

Organization of the Project

A scientific council will be set up to guide the programme, and at least three working committees: one on botanical research, one on zoological research, and one on biological data bases.

Expected Outputs

1. A series of publications on the biological resources of biosphere reserves.

2. The production of a computerized checklist of the biological resources protected in biosphere reserves.

3. An information system available to users through computer terminals diskettes as well as written printouts. This information system should have a standardized nomenclature system for plant and animal names and for localities.

4. A group of trained scientists and professionals in the area of biological inventories, resource evaluation, and data management.

5. Stimulation of permanent ecological and biological research activities in biosphere reserves. The establishment of a strong commitment of the scientific community to research and development activities in biosphere reserves.

6. An evaluation of the extent of protection for mankind's biological heritage in order to plan future actions in this regard.

7. A better understanding of man-made environmental disturbance and its impact on biological diversity.

In order to have a successful programme, we need two main factors: (a) the enthusiastic commitment of the scientific community and (b) the support— both intellectual and financial—of countries. We have had a very enthusiastic initial response from scientists and we are just starting individual national consultations.

THE ROLE AND THE VALUE OF THE 1984 ACTION PLAN FOR BIOSPHERE RESERVES

Richard Bill[1]

Abstract. In less than a decade, since the first biosphere reserves were established in 1976, the Man and the Biosphere (MAB) concept has grown into a large international network of 243 reserves in 65 countries (as of December 1984), with approximately half of the world's terrestrial biogeographical provinces represented with the network. In 1983, the First International Biosphere Reserve Congress was held to review the experience of the previous years and to set the general framework for future development of the network. This Conference resulted in the development of an Action Plan for Biosphere Reserves, which was approved by the UNESCO-MAB International Coordinating Council in December 1985. The Plan lays out 35 recommended actions for the period 1985-1989. These recommended actions can be used at the local level for individual reserves, as well as for the network at the national and international level.

INTRODUCTION

The Man and Biosphere Program was launched by UNESCO in 1971. The broad range of themes within MAB deals with people-environment interactions over the whole range of bioclimatic and geographic situations of the biosphere, from polar to tropical zones, from islands and coastal areas to high mountain regions, and from sparsely populated regions to dense human settlements. In sum, the Program was concerned with a worldwide program of international scientific cooperation which could be applied in these areas. It was designed to provide information needed to solve practical problems of resource management, to fill gaps in the understanding of ecosystem structure and function and human impact. Key ingredients are to involve decision-makers and local people with scientists from the social, biological and physical sciences in research projects, training and demonstration. It was recognized that environmental problems are complex and require multi-disciplinary approaches. The international biosphere reserve network was recognized early as an essential part of MAB.

The International Coordinating Council (MAB-ICC), which supervises the MAB Program, decided at its first session in 1971 that one of the themes of this programme was to be the "conservation of natural areas and the genetic material they contain." Under this theme was introduced the concept of the "biosphere reserve." This was to be a series of protected natural areas, linked through a coordinated international network, which would demonstrate the value of conservation and its relationship with development. These natural areas were to be places where MAB-related and other similar scientific activities could take place with assurance that the areas would not be disturbed or changed by man.

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This paper makes no attempt to lay out the criteria for selection of bisosphere reserves. It does not attempt to set the objectives for the international network; nor does it attempt to detail the characteristics of a reserve. These details are available in the other papers in this proceedings and in other published literature, through libraries which have been established in biosphere reserves. Instead, the emphasis will be placed upon the future work of the network, which is evolving out of the Action Plan for Biosphere Reserves (UNESCO, Action Plan for Biosphere Reserves. MAB, Paris 1985).

The international network is, in many ways, a voluntary network to which natural areas are added without formal commitments compared to international treaties. But there is a clear understanding that areas which are designated biosphere reserves by the MAB International Coordinating Committee (MAB-ICC), at the request of member countries, do meet the selection criteria which were established in 1974 (UNESCO). Final Report on Criteria and Guidelines for the Choice and Establishment of Biosphere Reserves. MAB Report Series No. 27, Paris 1974), and which are being reviewed in 1985. Few biosphere reserves will contain all the elements that characterize a specific biogeographical province. Thus, it may be necessary to designate several biosphere reserves in order to fully represent a province.

Each biosphere reserve is expected to meet at least some of the nine objectives which have been identified for the network. And, as the practical problems of biosphere reserve management are overcome, so it could be possible, given sufficient funding and interest for each reserve, firstly, to improve on its ability to meet some initial objectives, and, then secondly, to tackle additional objectives.

In less than a decade since the first biosphere reserves were established in 1976, the international network has expanded to include 243 reserves in 65 countries (as of December 1984). These 243 reserves of land, wetland and water include representative elements of half of the earth's 193 biogeographical terrestrial provinces. An indication of the continued growth of this network is that seventeen new reserves were added in 1984 alone, and others were referred for review in 1985.

Since the creation of MAB in 1971, cooperation in the fields of conservation and sustainable development has grown at least in parallel with the worldwide recognition of their importance. The Ecosystem Conservation Group (ECG) is one such form of cooperation between the Food and Agriculture Organization (FAO), the United Nations Environment Program (UNEP), the International Union for the Conservation of Nature and Natural Resources (IUCN) and UNESCO-MAB. This ECG provides the formal basis for cooperation in meeting the objectives of the international biosphere reserve network on a worldwide basis. It formally recognized that the principles of information gathering to solve practical problems of resource management on a multi-disciplinary basis can be greatly assisted through this network. For this purpose, the ECG meets regularly to ensure close cooperation.

A recent example of this cooperation was the First International Biosphere Reserve Congress held in 1983. The Congress reviewed the experience of the previous ten years and set up the general framework for future development of the network. Also, of crucial importance, the Congress brought together biosphere reserve managers, local people, decision-makers and scientists from most participating countries around the world. They were thus able to identify with the international network and to perceive how their reserves and their actions were having an impact on a worldwide basis.

ACTION PLAN FOR BIOSPHERE RESERVES

The result of the Congress workings and subsequent review is the Action Plan for Biosphere Reserves for the period 1985-89. This Action Plan was given formal approval by the MAB-ICC in 1984. From here, work on the Action Plan has taken two directions:

1. Formal approval is being sought from the Governing Councils of FAO, UNEP and IUCN at the international level; and

2. MAB National Committees in each country are encouraging their biosphere reserve managers and sponsoring organizations to include the Action Plan in the operations and management planning at the field level.

The second point is the most relevant in this paper, and, for this purpose, the main actions which are applicable to biosphere reserve managers, scientists and local people are summarized.

It should be noted that the Action Plan has been prepared as a framework for action rather than as a detailed plan with steps applicable equally at each biosphere reserve. This is because of differences in the ability of each reserve to respond to the main purpose of the plan--the promotion and implementation of the biosphere reserve concept and making it a more effective agent for sustainable development. This does not diminish the potential impact of the Action Plan upon each reserve. Rather, it sets up a series of goals which can be achieved with time and adequate support at each reserve.

What is required now is to translate these Actions into terms or ideas which can be understood at the local level. In order to strengthen each individual link in the international network, the Action Plan requires careful review and local objectives must be set; that is, local objectives which are attainable within a realistic budget and time frame.

There are three main thrusts in the Action Plan:

1. Improving and expanding the terrestrial network;

2. Developing basic knowledge for conserving ecosystems and biological diversity; and

3. Making biosphere reserves more effective in linking conservation and development.

Within the first thrust--improving and expanding the network--the onus for action lies largely with the members of the ECG--FAO, UNEP, IUCN and UNESCO--to lay out the criteria for future expansion. These include identifying gaps in the current network from two prospectives: identifying those reserves which are in need of assistance in broadening their fundamental objectives, and identifying those biogeographical provinces where ecological representation in the network is inadequate. Another action is to review and, where necessary, refine criteria for selecting new reserves.

The work in this area is of importance to "local" reserves in that it will, for example, help to raise the overall quality of the network, could result in "twinning" arrangements where the strong help the weak, and help nations identify ecological "gaps" in representation, as well as centres of endemism and genetic richness. In filling "gaps" the initiative moves to the "local" levels to get local participation in selecting and establishing new reserves.

Within the second thrust--using the network to increase knowledge--the work is spread more evenly between the national and local efforts on the one hand, and international support on the other.

With international and national help, individual reserves are being encouraged to select biological, chemical and physical variables for background monitoring which are of global and, perhaps, local value. Reserves are being encouraged to undertake research into basic ecological processes of value in local management and "conservation science" in general. Other important reserve actions which are identified include monitoring management effectiveness; collecting traditional knowledge of species and ecosystems usage; and spreading all such knowledge through as wide a variety of ways as possible to reach a wide public.

Within the third thrust--making biosphere reserves more effective in demonstrating the value of integrating conservation and development--the work remains cooperative, involving the individual biosphere reserve and national and international activities. It depends heavily upon the success of the network in the other two thrusts to be able to demonstrate its value.

Each reserve, having core and buffer area characteristics, should incorporate local people in its management, education, research, monitoring, demonstration and conservation functions. To be able to demonstrate the value of a reserve as an ecological model supporting sustainable development, those most immediately affected live within or beside the reserve have to be called upon. Local people are the most effective ambassadors who can relate to others who are being invited to change their approaches to the use of natural resources.

While it is clearly stated in the Action Plan that each government will establish its own priorities for implementing activities in biosphere reserves, a minimum set of activities are recommended for each reserve:

-- Preparation of a management plan which lists the steps to develop a biosphere reserve capable of handling a broad range of functions;

-- Preparing histories of research (for future activities);

-- Establishing research program(s) and facilities as required for a five-year period;

-- Establishing procedures for monitoring key biological parameters;

-- Compiling baseline inventories of flora and fauna species and their present and traditional uses (for future research, monitoring and information activities); and

-- Establishing an education/training/demonstration program.

The Action Plan is currently subdivided into groups of Actions. A synopsis of these is included as a table at the end of this paper, together with an indication of the time span anticipated, the cooperating "entities," and the priority and status of each Action. Because the Action Plan is aimed at the international network and the ECG, the "entities" do not spell out the Actions to be taken at the reserve level. Instead, it is proposed that "Governments" would imply close cooperation with reserve management and liaison committees.

CONCLUSION

The important step, as mentioned earlier, is to translate these Actions into terms and ideas which can be understood and implemented at the local biosphere level. This can only really be done in cooperation between the MAB National Committee, the relevant sponsoring agency (such as the U.S. National Park Service) and the local biosphere reserve. The approach can be to recommend Actions at the national level for implementation at the local level. Such an approach will provide the local manager and others with general goals which have to be modified by local experience and anticipated resources. Another approach can be to encourage local managers to develop local Actions which are achievable in terms of anticipated resources for the job but not necessarily meeting national objectives. The third approach is to combine the two: to match local resources and ideals and national objectives and support resources. The successful approach will depend upon each MAB national scene..

The challenge to creating a firm foundation for the international biosphere reserve network has now moved into a time period where goals or Actions are defined in general terms, and participating national and international agencies are in agreement in general terms.

The Actions now require careful delineation, the necessary resources (financial, human and environmental) identified, and a time frame applied to them.

Given the small central Secretariat office located at UNESCO–MAB, the onus for implementation is moving to the national level.

The next five years will be not merely an interesting time, but a crucial time for the biosphere reserve concept. Can the ideals be translated into a long–lasting reality: the promotion of ecologically sustainable development?

Editor's note: A copy of the Action Plan for Biosphere Reserves is provided in the Appendix.

BILATERAL APPLICATION OF THE MAB CONCEPT

H. Gilbert Lusk[1]

Abstract. The MAB concept is an effective resource management tool when establishing a common ground between nations, particularly when these nations are at different levels in their development. The evolution of Big Bend National Park and its long-term dealings with Mexico are briefly described, and an analysis is provided of the MAB concept as a central management and communication tool between nations. The Chihuahuan Desert, a sensitive region largely located in Mexico and represented in the United States by Big Bend National Park, is briefly described as the object of what is hoped will become a major international cooperative study zone under the umbrella of MAB. Also included is a review of an on-going case study in bilateral relations between Big Bend National Park and representatives of the Secretaria de Agricultura y Recursos Hidraulicos and Secretaria de Desarrollo Urbanos e Ecologia of Mexico.

The Big Bend region of Texas was first recognized for its natural and cultural significance and its potential as a national park in 1916. At a time when the United States and Mexico were involved with border problems and a state of military preparedness existed along the border, soldiers from the Pennsylvania National Guard, stationed at Big Bend, were writing home that the region should be declared a great national park. It was a time of Pershing, Patton, Villa and Harris--the last name that of a Pennsylvania soldier who saw through the conflict to the future of the area in an illustrated postcard to home. It was the first recorded mention of the area as a potential national park. Less than twenty years later, as the park was becoming a reality, discussions at the highest levels were ongoing about an international park with Mexico, similar to the Waterton-Glacier International Peace Park along the Canadian border. Frequent meetings were held to discuss the concept with Mexico and eventually an international park of some 2.5 million acres in Mexico and the United States was being proposed. The Presidents of Mexico and the United States both strongly endorsed the concept in the 1930's and it has since been endorsed by many of the Presidents of both countries.

Established by Act of Congress in 1944 to preserve a unique portion of the Chihuahuan Desert, Big Bend National Park has yet to be joined by a similar resource across the border in Mexico. The reasons for this make an excellent, though small, case study of international relations, resource management and of the possibilities offered by the MAB program in the management and preservation of natural resources.

What we have then is a series of observations and experiences detailing the current situation at Big Bend National Park and how both nations are striving, within their relative national goals, for a realistic and bilateral application of MAB or a similar program. It should be noted that the approaches and techniques mentioned are the result of a unique situation and are being implemented by a multi-national group of people with little or no experience in the sophisticated world of international relations. It represents a simple and sincere effort from the lowest common denominator of human interaction--friendship.

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[1]Superintendent, Big Bend National Park, Big Bend, Texas

Big Bend National Park was created to preserve and recognize the unique qualities of the Chihuahuan Desert---a relatively young North American desert with a marvelously complex diversity of plants and animals. It is a desert which is largely contained in the inter-mountain valleys of northern Mexico with only a small portion spilling over into the United States. In both countries, the region is one of limited rainfall and population, although in Mexico, the area is more isolated because of a lack of good roads and outside communication. Large land ownership patterns occur and population centers are few and far between. The economy in this area is limited by the terrain and desertification to ranching, tourism and harvesting of natural resources---this last element often involving illegal practices such as cactus and fur poaching and the harvesting of candelilla for production of wax.

There are, as well, underground economies such as the smuggling of drugs, contraband and other items between the countries and many Mexican citizens of the northern frontier, desirous of supporting their families, still illegally enter the United States to work. It is, in short, a beautiful but very demanding region of the world which would seem to welcome the economies represented by tourism and made possible by a large and beautiful international park.

With critical economic needs, a magnificent resource and strong support given by both countries for over fifty years, what has prevented the concept of an International Park from becoming reality? In reviewing the background and notes of meetings held over the decades and from my own observations, it is easy, if not entirely accurate, to make a few assumptions.

1. For fifty years, we have been dealing with a resource protection concept which is unrealistic for Mexico to embrace. The concept of a national park with protection of its resources from harvesting, hunting and multiple use will not allow Mexico to respond to its pressing needs as a nation. While other nations have developed national park concepts which permit flexible uses, much of the discussion between Mexico and the United States has centered on the United States' model of park management. To advance discussions pertaining to resource use and preservation, a broader and much more liberal concept was needed.

2. We expressed interest in a companion park in Mexico so long as it didn't become developed. A wilderness area was sought with strict protection and this, as indicated, was a most difficult concept for Mexico to deal with. As a National Park, Big Bend and its management should be concerned with the level and type of development which occurs around the park, but we cannot expect a nation which is in need of economic stimulation and growth to agree to the freezing of major resources and to the non-development of those resources by restricting roads, lodges, campgrounds, village growth, etc. There are accordingly two options: stick to an uncompromising resource management concept and gain little, or be willing to compromise on the question of use and development and set the stage for potential long-term resource enhancements. Either way, it is up to Mexico to do with their country as they must and for us to support or consult when asked. We should not, however, place unrealistic obstacles in the way, and we must recognize that Mexico cannot support massive wilderness areas at this point in their history.

3. Discussions about the park have, in the past, been held with representatives of the scientific community and with a few interested parties at the state level in Mexico. Our approach on the issue of a preserve has largely been from the top down as opposed to the bottom up. We have simply not taken enough time to establish strong

1. A thorough review of all park policies was conducted to assure consistency of application for all park neighbors. Did we, in effect, respond to our neighbors in the United States in one way and to our neighbors in Mexico in another? When such a policy was found, and there were a few, we adjusted or changed it to reflect an even-handed treatment of everyone, regardless of citizenship.

2. Goodwill Ambassadors were assigned from within the park staff to interact with the three Mexican villages directly across from the park. The intention of the program is to provide direct communication with village leaders and also to listen to any concerns from them in regard to our policy and management. Although the park has a large staff of Hispanic employees, the ambassadors were selected from the ranks of our Anglo employees to help convey the fact that everyone in the park was supportive of the effort. People with an interest in cross-cultural exchange and improvement of their language skills were selected.

3. A Fall good neighbor fiesta concentrating on cultural exchange was established for the park community, Mexican villages and park visitors. The emphasis of the program is on a positive program of events for the school children of both countries. The fourth annual fiesta held this October presented entertainment from both countries and featured the Ballet Folklorico from Chihuahua City, Mexico. The fiestas have become a focal point for building our village relations.

4. Primary emphasis was placed on the recruitment of personnel who had some Spanish language ability and who were interested in cross-cultural opportunities. The number of people who speak some Spanish has increased substantially in the past four years.

5. A program was undertaken to assure that all exhibits and publications in the park would become bilingual over a fixed period of time. Every effort has been made to help people realize that Big Bend is on the Mexican border and that it is an international experience.

6. At the same time, every effort is being made to place the park in perspective with the border. The simple scenario that Mexico is a fun and exciting place to visit inhabited with some of the most gracious and fun-loving people imaginable is much needed. Too much emphasis has been placed in the past on the romantic "banditos" and many people still falsely think of Mexico as a dangerous place to go.

7. Visits are made to the state capitals of Saltillo, Coahuila and Chihuahua City, Chihuahua, Mexico across from the park. Meetings are held with state Governors, their staffs and various federal officials of several resource management agencies. Discussions are often wide-ranging and focus on ways we can be of mutual assistance to one another.

8. Park personnel and Mexican officials have participated in site visits to consult on resource questions. This includes several conferences, cross-training programs and orientation visits. These officials have participated in our annual fiestas and other functions as well. Strong friendships exist in several locations as a result of these exchanges.

9. Discussions and consultations have been held at Big Bend and in the mountains of Mexico to discuss the "international park" and to determine if there is a workable concept. Resource professionals within the Secretaria de Agricultura y Recursos Hidraulicos and the Secretaria de Desarrollo Urbano e Ecologia have been involved and a proposal developed by them has been submitted to Mexico City where it has

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received initial support. The area under discussion has been visited by many federal officials from Mexico City. While still not a MAB concept, the proposal will adapt quickly and without change to the MAB format, if Mexico so chooses.

10. Two conferences are being planned for 1985 along the U.S./Mexico border. Both would be co-sponsored by the National Park Service with one, co-sponsored by the Texas Historical Commission, dealing with the cultural resources (historical and archeological) of the border and the other, co-sponsored by the Texas Parks and Wildlife Department, dealing with various park and recreation issues affecting the border. Mexico would hopefully be heavily involved in both conferences and with the numerous working arrangements and projects which might result.

11. Communications have begun with village officials in Mexico and with professional archeologists in Texas and the National Park Service regarding a major research effort on the Presidios of San Vicente and San Carlos, Mexico. Both presidios, built in the late 1700's, are outstanding examples of frontier development along the Rio Grande and will yield valuable evidence of the Spanish Colonial Period.

12. Avenues have been opened via personal contacts in Mexico for U.S. scientists to conduct research in the Maderas Del Carmen on private lands managed by Secretaria de Agricultura y Recursos Hidraulicos. All such researchers must provide copies of their research to appropriate offices in Mexico to assist in building their data bases.

All of this and more has been made possible because we have been willing to pursue a concept of awareness and involvement as embodied in the MAB program. While discussions have not specifically dealt with the MAB program as yet, the Mexican proposal for a Maderas Del Carmen unit in Mexico is premised on many of the concepts embodied within the MAB program.

The Chihuahuan Desert represents a magnificent ecological unity whether you are in the Chisos Mountains of Big Bend National Park, Cuatro Cienegas or the Maderas Del Carmen in Mexico. The resources of that desert neither recognize nor understand the differences which man had put upon the desert in terms of political and social conventions. At some point in past time, man pointed his finger at the Rio Grande, or as it is called in Mexico, the Rio Bravo del Norte, and said that the Chihuahuan Desert to the north of that river would exist in one economic and social climate and the desert to the south would exist in another. The Man and the Biosphere concept is an international concept reaching out and indeed demanding bilateral consideration, stimulating us to consider the desert in scientific and not political terms. But stimulated as we may be, we must in our dealings and associations recognize the differences between our countries.

The differences represent more than those that exist between an industrially advanced nation and a still-developing nation. It's the difference between a nation which has the luxury of thinking of the desert as a beautiful place and a nation which must make the desert a place of survival and growth; between a nation which protects its plants and animals because they are endangered and harmonious and a nation which must use these resources for food, clothing and economic return. Neither nation is wrong, they are merely in time with their relative levels of development. In approaching discussion of resource management concepts, we must recognize that there are differences and avoid the arrogance of a developed nation in preaching to and/or trying to change where another nation must be in its historic continuum.

The resource professionals of Mexico are as well trained and caring of resources as any in the United States or any other country, but they must be pragmatic and make extremely difficult decisions regarding use of their resources. The United States had the luxury of dealing with resource issues such as are facing Mexico during a historic period of sparse and largely dispersed population. Mexico must deal with its resource problems during a time of heavily concentrated and growing population with small margin for error. Their challenge is infinitely greater.

As we recognize and analyze these facts and as we do our very best to avoid typical "Ugly American" approaches, the Man and the Biosphere concept becomes a significant tool for dealing with resources. It is, after all, a concept eminently suited to resource issues regardless of where a nation may be in time and development. It allows the United States to continue on with its policies as represented by national forests, national parks, etc., and it allows a nation like Mexico to have MAB areas and yet continue the necessary harvesting and development of its resources. It provides a nation with a pattern around which long--term goals and objectives can be established. It provides thinking ground and a place where additional discovery may yield greater productivity or greater understanding. It is a bilateral concept.

BIOSPHERE RESERVES IN THE UNITED STATES: PROTECTED AREAS FOR INFORMATION AND COOPERATION

William P. Gregg, Jr.[1]

Abstract. Biosphere reserves are contrasted with national parks in terms of the symbolism which influences people to act on their behalf. The evolution of the biosphere reserve concept in the United States during the last decade is described, and an assessment is provided on why the biosphere reserve designation has yet to influence protected area management significantly. Future emphasis in the U.S. will focus on expanding and consolidating the existing network to foster more effective conservation of representative ecosystems, and on developing the multiple functions of the reserves. The roles of UNESCO and U.S. MAB organizations, and the implications of U.S. withdrawal from UNESCO at year's end on the biosphere reserve program are discussed.

Additional keywords: national parks, protected areas, resource management, UNESCO

This audience is overwhelmingly a national park audience . . . people working in parks and similar protected areas as administrators, scientists, resource managers, interpreters . . . heirs to one of the most inspired movements in human history . . . lovers of the splendor of a boundless creation . . . stewards with the awesome responsibility of leaving the treasures of this creation unimpaired to nourish the spirits of generations yet unborn.

By our presence here today, we are participating in a year-long celebration honoring the creative miracle of this beautiful park. We honor the decision 50 years ago to protect it. And we acknowledge our sacred obligation to assure its future, just as we acknowledge the enormous challenges before us.

Unprecedented change is occurring. Environmental. Social. Economic. Like it or not, we, and the parks we serve, are a part of this change. And the future depends on our ability to accept the inevitability of change, and to deal with it creatively and cooperatively. To do this, we will need the best information and technology; and we must marshal the help and goodwill of others as never before. As we have always done, we must protect the health of the park within the boundaries. But now we must also look outward, beyond the boundaries, to nearby and distant sources of changes, and be a part of efforts to deal with them. We must understand the ecosystems and the gene pools in our charge, and how changes are affecting them. We must be ready to respond to crisis, but more importantly we must be able to act confidently to head off crisis. Finally, we must learn to work with others whose management objectives are very different from our own, and we must do so in ways which make development more sustainable and protected areas more secure.

Everyone in this room is aware of the challenge. And I hope everyone is asking, along with me, how the biosphere reserve designation can help us meet it. In the United States and Canada, 52 protected areas have received what, to most field personnel, remains a mysterious blessing. I offer you no panacea for your uncertainty. Barely eight years have passed since the first biosphere reserves were designated. The concept

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is new. It is evolving. And it is being discussed, increasingly, in the 62 countries that have biosphere reserves and in the many others which are considering them. Out of these discussions is emerging a clearer concept of a unique category of protected area, unique in its positive symbolism, and unique in its role in the advancement of human civilization. So, while I can offer no panacea, I can provide some perspective on the concept, how it is being developed in the U.S., and where I see it headed in the next few years.

A NEW POSITIVE SYMBOLISM

Let us look first at the symbolism. For biosphere reserves to have much impact, people must be motivated to act on their behalf. For this to happen, the name "biosphere reserve" must evoke an immediate, positive, and reasonably consistent emotional response. People must relate to the biosphere reserve as a unique category of protected area, distinct from all others. The symbolism must be crystal clear.

The success of the national park concept has been due to an overwhelmingly positive symbolism. When people think of national parks, the vision is one of breathtaking landscapes and superlative natural features. For huge numbers of people, the emotion is one of pride in a nation's natural heritage, and protectiveness toward a miracle of creation. Millions of us have intense personal relationships with these environments. The sense of spiritual renewal and opportunities for fellowship we find there can be duplicated nowhere else. The national park symbolism is clear, effective, and enduring and its ability to motivate people has been greater than for any other category of protected area.

To me, the symbolism of the biosphere reserve is as compelling as it is different from the national park. It is a symbolism which reflects the purpose of the Man and the Biosphere Program; namely, to put knowledge and human cooperation to work to build harmonious relationships between people and their environment. When I think of a biosphere reserve, my vision is, first, one of a large, self-sustaining, well protected ecosystem containing an inexhaustible archive of information for the future benefit of people . . . information contained in ecological relationships and genetic codes . . . information waiting to be unlocked through scientific study and put to use through enlightened management.

My vision is one of people working together at the local level to develop knowledge, skills, and human values and to build a working model for sustainable conservation of a biogeographic region. My vision is also of a center for cooperation among nations to find solutions to environmental problems, like atmospheric pollution, which affects large parts of the globe. My emotion is one of caring for the condition of the human family and the world's ecosystems. It is one of enthusiasm for working with others to improve that condition. Just as for national parks, I feel intense protectiveness; but my focus extends beyond the resources themselves to the irreplaceable library of information for human well-being that biosphere reserves represent.

THE IDEAL BIOSPHERE RESERVE

According to UNESCO guidelines, the ideal biosphere reserve is a securely protected landscape. It includes representative examples of the ecosystems of one of the world's 193 biogeographic regions. It contains as much biological diversity as possible. The ecosystems are self-regulating, and allow for the natural evolution of genetic resources. This protected core is used for studying ecosystems, how they operate, and how they respond to natural changes and changes caused by external human activities,

such as pollution. The core is also the control area for comparison with other areas of the biosphere reserve, located outside the core. Some of these areas are manipulated experimentally to develop better production systems for livestock, forest products, fish, or other commodities. Others are used to find ways to rehabilitate disturbed ecosystems. Where indigenous people are living in harmony with the environment, still other areas are used to study and learn from the experience of these people.

As a management concept, the watchword is integration . . . Integration of functions at the site: monitoring, experimental research, resource management, demonstration, professional training, public education . . . Integration to build a model for sustainable conservation of a particular natural region . . . Integration of activities at different levels to help solve problems locally, regionally, and internationally . . . Integration through cooperation within the management team at each site, between the staffs of nearby sites, between managers and local people, between professionals in different institutions and countries.

BIOSPHERE RESERVES: THE UNITED STATES APPROACH

Early History. Although the United States was involved in the early discussions which led to the biosphere reserve project, our formal involvement dates from 1974. The project was floundering because United Nations funding failed to materialize. To give the project a boost, a provision was included in the Nixon-Brezhnev Summit Communique in July 1974, committing each country to establish biosphere reserves and to cooperate in their development. During the ensuing months, our National Park Service and Forest Service worked at breakneck pace to identify sites. Using selection criteria just published by UNESCO in May, they identified 16 sites. In November, 1974, the United States, accompanied by Austria, France, the Philippines, and the United Kingdom, announced the establishment of biosphere reserves at the annual meeting of the MAB International Coordinating Council. The project was off and running. A year later, UNESCO developed official designation procedures; and in 1976 the first official designations were made. Among the 29 units designated in the U.S. were the 16 sites in our original network.

The Cluster Concept. From the start, the United States recognized that it would be impossible to select single sites where all the biosphere reserve functions could be carried out. National parks, wilderness areas, and similar sites worked well as core areas, but were unsuitable for experimental manipulation, demonstration of sustainable production systems, and most rehabilitation projects. Experimental forests and rangelands, and similar areas, accomodated experimental research, but rarely had areas for conservation of large, self-sustaining ecosystems. Multiple- use areas, such as those managed by the Bureau of Land Management, often worked well for demonstration and rehabilitation, but not for other functions. Traditional use areas were confined to Alaska, scattered Indian reservations, and a few other areas, and were seldom associated with protected areas.

From 1976 through 1980, we tried to pair large conservation areas with experimental research sites in the same biogeographic region. Through this so-called "cluster concept," we hoped to encourage cooperation among the separate biosphere reserves in carrying out the various functions within the region. The approach resulted in the designation of Great Smoky Mountains National Park and the Coweeta Hydrological Station in the Southern Appalachians; of Glacier National Park and the Coram Experimental Forest in the northern Rockies; and of Big Bend National Park and the Jornada Experimental Range in the Chihuahuan Desert. Unfortunately, the amount of cooperation between the paired biosphere reserves was disappointing. Many of the sites

were hundreds of miles apart, in different ecosystems, and had very different research and management objectives.

Current Approach. In 1981, U.S. MAB began a systematic selection process to expand and consolidate our network in each of the 25 terrestrial or 13 coastal regions of the U.S. and its territories. Region by region, we are convening special panels of scientists and protected area administrators. The experts identify the representative ecosystems to be included. They identify the candidate sites potentially available to build biosphere reserves. They determine the physical, biological, and administrative factors to be used for describing and comparing the sites. They assess opportunities for developing biosphere reserve functions. They evaluate the candidates individually and in groups against UNESCO's criteria. Finally, they recommend sites for nomination by U.S. MAB as biosphere reserves, pending concurrence of their administrators.

Most panels recommend several biosphere reserves in the selection region. Each reserve is named after a characteristic natural feature like the California Coast Ranges or the South Atlantic Coastal Plain. Each typically contains several administrative units which together enable as many of the reserve's functions to be carried out as possible. Priority goes to well-protected "benchmark" areas, or core zones, for conserving and studying natural ecosystems. We include areas for experimental research, demonstration of management methods, rehabilitation of degraded landscapes, and for studying traditional uses, if such areas are available and if their owners are willing. The core and the associated research and educational areas are the basic information-generating units which make up the biosphere reserve. The success of the reserve in providing the scientific basis for sustainable conservation, then, depends fundamentally on coordination of these areas. Obviously, the more nearly contiguous these areas are, the better the chances for success.

In some cases, the "information" sites are contained within a larger multiple-use area. If this area is being managed compatibly with the conservation, research, and educational sites, the panel may recommend its inclusion as an area of cooperation (i.e., an expanded "buffer zone"). Legally established multiple-use reserves, like the New Jersey Pinelands, or special multi-agency planning districts, like California's Santa Rosa Mountains Wildlife Management Area are examples. More often the area of cooperation does not appear as part of the nomination, but develops gradually as cooperative management activities take place after the reserve is designated. The area thus varies in space and time depending on the cooperative activities being carried out. Once successful cooperative management becomes a reality, some of these areas may elect to join the biosphere reserve officially- but it may be some time before we see this occurring.

Few nominations are complete. There are nearly always gaps in ecosystem representation and biosphere reserve functions, because suitable sites or willing administrators do not yet exist. The panel notes the gaps, and may suggest ways to fill them, but gaps do not and should not prevent us from establishing a biosphere reserve. They do mean that we must build the biosphere reserve opportunistically over the years until the gaps are filled.

The actual nomination procedure can move quickly. The panel sends its report to the Project Directorate on Biosphere Reserves, which contains representatives from all major Federal land managing agencies and several organizations and universities. The Directorate approves sites for nomination. Before the U.S. actually nominates a site, however, the MAB Secretariat at the State Department requests written concurrence from the administrator. Once this has been obtained, the Secretariat transmits the nomination to UNESCO for review by a newly-established international advisory panel on biosphere reserves, which meets as necessary. Although terms of reference for the

panel have not yet been adopted, it is expected that the panel will recommend sites for approval by the bureau of MAB's International Coordinating Council and official designation by the Director-General of UNESCO, who signs the official certificates which are sent to the site administrators. The whole process, from the panel's first session to designation, takes about 18 months.

THE ROADBLOCKS

To me, biosphere reserve designation for a national park or other protected area should add new dimensions to its mission, new challenges in its management, new reasons for its secure protection, and new constituencies for its defense. However, it is not surprising that the reality falls short of the ideal. Why?

Too New a Concept. It has been only eight years since the United Nations designated the first biosphere reserves. The concept is still evolving. It is still being adapted to the different conditions in MAB countries. Its symbolism is still crystallizing. Can we reasonably expect an idea so new and so different to energize our community in so short a time? I do not think so.

Slow Flow of Information. MAB's success in getting out the word on biosphere reserves to field personnel and the public has been disappointing. Lack of nontechnical media materials is one reason. We are preparing a new brochure and a slide-tape program, and we are preparing a video documentary at this conference. These should help. Another problem has been insufficient administrative support. I spend most of my time on the project and have several part-time students to help with program planning, selecting biosphere reserves, answering requests, and coordinating projects. However, we have far more work than our one person-year can handle. MAB's Secretariat at the State Department has a staff of two, plus some irregulars, yet it serves the entire U.S. MAB program, which has ten major project areas, of which the biosphere reserve project is but one. The planned strengthening of the program in 1985 will mean a larger and more effective Secretariat, and better communication.

Emphasis on Numbers Rather Than Functions. Since 1976, MAB has devoted its limited resources primarily to expanding the biosphere reserve network. The international network now counts 243 reserves in 65 countries (January 1985 data), including 41 in the U.S. and 2 in Canada. By any measure, this is a significant accomplishment for a program barely a decade old. However, with notable exceptions, we have yet to pursue the opportunities the designation and the network provide, and to develop demonstrations which convince people of the practical benefits of the biosphere reserve approach.

Perception: Scientists in Control. Because research is a key function, scientists are interested in biosphere reserves. The project's initial impetus came from scientists. Support today comes largely from scientists. As a result, resource managers and users often feel that the only beneficiaries are scientists. This view is widely held in spite of the overriding mission of the designation to approaches to management. Last year's World Congress on Biosphere Reserves in the Soviet Union focused on the biosphere reserves' role in solving land use and management problems. For the first time, managers are beginning to explore the opportunities and the potential benefits of biosphere reserves. Our workshop here is an important step in this search.

MAB: The Disappointing Benefactor. Some U.S. biosphere reserve administrators have expressed disappointment because they have yet to see tangible benefits in terms of MAB-funded projects. The designation has been misperceived as providing a

supplementary source of funds, rather than a basis for expanding and redirecting the administrator's own programs. For a time between 1979 and 1982, some administrators did benefit from a MAB research grant program, which funded a score of projects involving U.S. biosphere reserves, among others. This program became inactive in 1983 because the participating domestic agencies failed to fund it. MAB's funding picture improved slightly in 1984, is likely to be somewhat better in 1985, and should be much better in 1986. However, MAB is unlikely ever to be a major direct source of project funds for most reserves. Instead, its function is more likely to be catalytic by providing seed funds and the MAB imprimatur for cooperative activities which serve the management objectives of the reserve and the mission of MAB.

The "Good Management" Problem. Biosphere reserves are a different breed because of their functions and the way they are carried out. Cooperative resource management programs, regional and national pollution monitoring, interdisciplinary research, environmental education, professional training activities, and international cooperation are all important activities in many U.S. biosphere reserves. Yet, the biosphere reserve rarely is recognized for such activities. Even when activities are peculiar to biosphere reserves, they are invariably credited simply to "good management." Hopefully, one output of this workshop will be to identify activities which warrant the biosphere reserve "label" so that we can use the biosphere designation to encourage them.

No Legal Obligations. Participation in the international network of biosphere reserves is strictly voluntary. Unlike World Heritage Sites, biosphere reserves have no international treaty governing their designation. In most countries, designation carries no domestic legal obligations. At a time when management is increasingly dominated by laws and regulations, administrators have tended to see the designation as a gratuitous honor, rather than a new opportunity for expanding a protected area's mission. This view ignores the biosphere reserve's role in marshalling moral energy for cooperation to solve land use and management problems . . . in bringing people and institutions together to develop the knowledge, skills, and human values that make solutions possible. The view ignores the particular benefits of the biosphere reserve approach in helping the manager deal with land use changes and other external influences which are outside his or her legal authority.

As a final consideration here, let me say that administrators accept biosphere reserve designation largely because of the voluntary nature of the program. This has enabled the network to grow rapidly. It has also enabled us to forge symbolic linkages among complementary protected areas within a biogeographic region--linkages which can be formed only through the biosphere reserve approach.

FUTURE DIRECTIONS

Restructuring the Network. We will continue to restructure the U.S. network in the years ahead. We will continue to convene selection panels to identify the gaps and recommend protected areas to fill them. At the present rate of three or four panels a year, it will take about a decade to cover the entire country. We will continue to link ecologically and functionally complementary sites to give us better opportunities for carrying out the multiple functions of biosphere reserves. Administrators of existing reserves will be asked to join multiple-site biosphere reserves, which will bear the names of natural regions or features. We will keep track of those who turn down nomination so that we can pursue opportunities later. In this way, we will gradually create large protected landscapes through voluntary cooperation, rather than by law

or regulation. By linking contiguous areas, we will make boundaries more ecological and less political. We will provide a symbolic and practical framework for coordinated management of entire watersheds, mountain massifs, estuaries, reefs, important wildlife habitats, and other ecological units. We will create opportunities for establishing protected areas as information resources and as centers for cooperation. We will create opportunities to demonstrate that we can manage ecosystems for a wide range of amenities, environmental services, and commodities, while conserving natural processes and gene pools. We will create opportunities to enhance the importance of protected areas to human well-being, while improving their security. However, the opportunities will remain just opportunities until we take advantage of them.

<u>Developing the Functions</u>. "What's in it for us?" is a question frequently voiced by field personnel! In fact, it is probably the central question of this conference. Clearly, windfall management profits have not followed on the heels of designation. But, then again, should we really expect immediate benefits from a designation designed to encourage cooperation and development of protected areas as "information resources"? These things take time. They take initiative. They may even take new perspectives.

The benefits from designation come from developing functions rather than from the designation itself. They come from acting on the symbolism, from our personal initiatives. So, instead of the one question, let me suggest ten to focus on the areas where we can expect benefits:

(1) Does our information from monitoring make us confident that we can detect, evaluate, and distinguish natural and human-caused changes in ecosystems . . . even the subtle changes?

(2) Is our research interdisciplinary? Does it involve both natural and social sciences? Is the information helping to solve the interrelated environmental, land use, and socioeconomic problems of the region?

(3) Is comparative research on undisturbed and manipulated areas giving the region sustainable production methods? Is it helping us understand how ecosystems operate?

(4) Are degraded ecosystems being successfully restored?

(5) Is cooperation with other sites in the international network giving us better perspective on problems of common interest?

(6) Is the reserve demonstrating how to manage ecosystems for a wide range of amenities, environmental services, and commodities? Is it showing how to conserve biological diversity under various management strategies?

(7) Is the reserve a regional or international center for the education and training of scientists, land managers, and resource users?

(8) Are local people involved in setting objectives and in management planning? Do local people benefit from the reserve? Do they support the reserve?

(9) Is the public being informed about how people depend on healthy ecosystems? About how protected areas are helping to solve environmental problems at home and abroad? About how the particular biosphere reserve is helping?

(10) Are there productive relationships with regional universities, institutions, organizations, and agencies? With the economic development sector? Are their capabilities being marshalled to solve problems?

Most U. S. biosphere reserves can answer "yes" to some of these questions, but none can answer "yes" to all of them. Sometimes this is because the biosphere reserve does not yet include sites for carrying out particular functions. Sometimes it is because we have yet to consider the functions.

It seems to me that, if we act together on behalf of the biosphere reserve concept, we shall eventually be able to answer "yes" to all of these questions. Some of the things we might do are listed in the Appendix. Once the leap of the faith has been made, biosphere reserves will acquire a unique identity. They will be recognized as centers for information and cooperation. They will become models for successful management . . . and the benefits will be obvious.

HELP FROM MAB

Once the leap of faith has been made, MAB can help biosphere reserves develop their functions. How?

MAB can foster international cooperation to help biosphere reserves contribute in dealing with pollution and other problems of international concern. UNESCO's MAB Secretariat in Paris can provide travel grants to help bring together specialists, from whatever country, without red tape. It can provide endorsements and "seed funds" to launch worthwhile international projects. It can help coordinate international workshops. It can provide information on sites and activities in the network. It provides access to MAB organizations in 105 countries and thousands of specialists participating in MAB field projects.

In the U. S., the Secretariat at the State Department supports MAB through funds provided by several agencies, including the National Park Service, the Forest Service, and NASA (and hopefully someday the private sector). It gives access to the capabilities of MAB's participating agencies, universities, organizations, and hundreds of project specialists. It furnishes information on MAB activities through its newsletter. It publishes MAB reports and provides guidelines for selecting biosphere reserves and carrying out biosphere reserrve functions. It can help fund ecosystems monitoring. It can help fund research, which is interdisciplinary, international, ecosystem-oriented, problem-oriented, and future-oriented. For various reasons, such projects may not compete well in agency programs but they are often are the ones which can help chart new directions in resource management. For example, MAB now funds research on management of genetic resources, on the design of protected areas, on models for assessing protected area boundaries, on ethnobiology and on the traditional land use practices of indigenous people, on comparative assessment of pollution effects in different ecosystems, and on restoration of degraded ecosystems. It supports cooperative projects with Brazil, Canada, Chile, the Lesser Antilles, Mexico, and the Soviet Union, among others. It is helping with demonstration projects, such as the automated geographic information systems for managing the Everglades and Great Smoky Mountains Biosphere Reserves, and comparative ecological modelling in three experimental biosphere reserve sites.

Like the Paris Secretariat, U.S. MAB is a catalyst for conferences and workshops on topics of interest to biosphere reserves. By our endorsement and seed money, we can help bring other supporters on board. This conference is an example, but I could also

cite last year's widely acclaimed conference on the management of genetic rosources, which launched exciting discussions on new areas of management. I could cite MAB's workshop on biosphere reserves for sustainable development in the Lesser Antilles, which launched the idea of a multi-island biosphere reserve for solving the problems in the region . . . and I could cite many more.

MAB can help public education programs become more relevant to the environmental issues of our day. It can give them new life and meaning. Our exhibit on biological diversity, which you can see in the poster hall, is an example. Here, we have used familiar images, like the all-American hamburger, to demonstrate the importance of conserving diversity in our everday life, and to foster understanding of a generally unappreciated mission of biosphere reserves and other protected areas.

MAB can help build new mechanisms for managers to look outward through cooperation. MAB can make the manager's job easier by helping to defuse and prevent conflict. Here in the Southern Appalachians, and more recently in the Virgin Islands, there are regional resource management cooperatives which bring together agencies, universities, and other regional institutions to solve problems. These cooperatives were first promoted by MAB people, and have been stabilized by MAB concepts and MAB associations. At Canada's Waterton Lakes Biosphere Reserve, a MAB cooperative helps park managers and neighboring ranchers identify problems and coordinate their actions to solve them. In Mexico, MAB associations enable campesinos to participate in the planning and management of biosphere reserves, and are largely responsible for eliminating poaching and other problems through local initiatives and support.

If you are interested in information on MAB, or in obtaining endorsement or assistance from MAB on specific projects, you should contact the Executive Director of the MAB Secretariat at the Department of State, or one of the co-chairmen of MAB's Project Directorate on Biosphere Reserves (Dr. Stanley Krugman, Forest Service, or myself). At this time, MAB's capability to fund projects is limited, because the Secretariat's FY1985 budget from all sources will probably be no more than $250,000. The practical effect is that only projects involving very modest MAB contributions are likely to be very competitive this year. However, the prospect for increasing this budget at least several-fold in FY1986 is promising. For this reason, 1985 will be a year of planning for MAB's future expansion, and the Secretariat and the Directorate welcome your ideas for specific projects in biosphere reserves.

U.S. WITHDRAWAL FROM UNESCO AND THE STATUS OF MAB

The Administration's decision to withdraw from UNESCO at year's end has drawn unprecedented attention to MAB. Congressional hearings have repeatedly recorded MAB's benefits to the United States. The National Science Foundation did the same in a recent evaluation of UNESCO science programs. Letters of support for strengthening MAB have poured in from participating agencies, conservationists, and scientists. The National Academy of Sciences has recommended ways to keep the U.S. involved in MAB after we withdraw, and we are confident that the Government will act favorably on these recommendations.

U.S.-MAB has streamlined its organization, and established new priorities, including completing the biosphere reserve network and strengthening its functions. State is expected to add three new positions to the Secretariat in FY1985. More agencies are coming on board. The most recent was NASA, which began funding MAB last year, primarily because of its interest in biosphere reserves. The interest is there. Although

we do not yet know exactly what our participants will do for MAB in 1985, we are confident that they will maintain and perhaps increase their collective support.

After the U.S. leaves UNESCO next month, we will lose our membership on MAB's policy-making body (i.e., the I.C.C.). The impact is more a long-term than an immediate concern for the biosphere reserves project. If, as expected, the U.S. funds MAB projects directly rather than through its unrestricted contribution to UNESCO beginning in FY1986, the number of international projects involving U.S. biosphere reserves could well increase significantly . . . this as a result of a proposal to reallocate $2 million to MAB from funds formerly provided to UNESCO. Regardless of the outcome, we expect that UNESCO will continue to designate U.S. sites as biosphere reserves. Our specialists will still be involved in MAB activities, and our managers can rest assured that they will not have to turn in their biosphere reserve certificates and plaques!

(Note: at the December 1984 meeting of MAB's International Coordinating Council, a scientific advisory panel on biosphere reserves was established to review nominations, provide professional oversight of the biosphere reserve projects and make recommendations to the Council. U. S. scientists will participate on this panel, thus assuring continuity in our involvement.)

CONCLUSION

More funding for MAB can help us build more effective and more functional biosphere reserves, but the key ingredient in the project is people . . . people who see the value of protected ecosystems as informational resources for the advancement of our civilization . . . people who are willing to put protected areas to work as places for human cooperation in building a more productive and stable world . . . people who understand that developing protected areas as biosphere reserves can mean a more favorable environment for their security, new constituencies for their protection, and better tools for their management. You, the biosphere reserve managers, scientists, and interpreters, are the key. The concept can enable you to pursue new opportunities, improve your communication in the region, develop better perspectives on important resource management problems, and expand the dimensions of your service to the public. Voluntary actions alone are the best way to establish the identity of biosphere reserves as a special category of management, and these depend on you. Without your enthusiasm, the concept cannot succeed; with it, it cannot fail.

BIOSPHERE RESERVES AND REGIONAL COORDINATION

John D. McCrone[1]

Abstract. The mobilization of regional constituency groups in support of biosphere reserve activities helps develop a stable political base, a network for information exchange, and a source of direct functional support. Examples are given of involvement of scientists, educators, legislators, public officials, special interests groups, businessmen, professionals, and the media in reserve programs. Various organizational models in selected reserves are described and discussed.

It is becoming increasingly clear one of the major factors in attaining biosphere reserve objectives is the mobilization and utilization of key constituencies within the region around the reserve. As Gregg (1984) has pointed out:

> "The success of a biosphere reserve depends on the involvement of large numbers of people, working together in a spirit of service to make each reserve a regional center for the study of natural and managed landscapes; for demonstrating improved resource management techniques which are sensitive to the capabilities, social organization, and cultural traditions of a particular region; and for building a conservation ethic by furnishing education, practical training, and basic material resources to improve the well-being of the people on whose shoulders the protection of the reserve and the conservation of the region ultimately depend."

The value of mobilizing these constituency groups is that they provide a means to develop a stable political base for reserve activities, a network for the exchange of information, and a source of direct functional support for reserve programs.

The importance of political support at the local, state, and federal level cannot be underestimated. I think it fair to say, with some exception, that political support for the biosphere reserve network outside the scientific community in the United States is largely confined to a few members of Congress, their staffs, and interested agency officials. This dedicated cadre must be reinforced by gaining the support of key public officials at the regional level by direct personal contacts and indirectly by enlisting the support of their constituents. To accomplish the latter, an effective program for the exchange and dissemination of information is essential. Special interest groups and the media can play a key role here. The special interest groups, ranging from conservation organizations to organizations representing businessmen and professionals, provide convenient forums for the presentation of programs about biosphere reserves, their activities, and their importance to the region. If these presentations are well done, they will be reported by the media. Often the media will follow up with feature articles if approached with a theme or message that will capture public attention. For example, in our region there is a great deal of interest in the effects of acid rain. An article linking the monitoring responsibilities of biosphere reserves with an issue such as this would generate considerable interest.

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At the functional level, the involvement of constituency groups directly in reserve activities is most important. No reserve has a staff of the size that would be needed to carry out effectively the monitoring, research, training, environmental education, management and public information activities associated with reserve programs.

Since many reserve activities require the talents of scientists, it is essential that mechanisms be developed to involve this important constituency. These can range from unilateral arrangements with individual scientists, to group activities such as the "pulse" studies conducted in the West by Jerry Franklin and his associates, to highly organized research consortia such as those that now operate in the Southern Appalachians and the Virgin Islands.

Linkages with regional educational institutions greatly enhance reserve programs directed toward training and environmental education. The MAB training program for natural resource managers from less developed countries, conducted by Frank McCormick and his associates at the University of Tennessee at Knoxville, owes its success in part to the collaboration with the Rocky Mountain and Great Smoky Mountains biosphere reserves. At the Mont-Saint-Hilaire Biosphere Reserve in Canada, the principal activity is an environmental education/training program involving educational institutions in the region.

Previous reference has been made to the importance of developing political support for biosphere reserves. In North Carolina, the N. C. National Park, Parkway and Forests Development Council, an agency of the N. C. Department of Commerce, is an effective forum for linking the National Park Service and the U. S. Forest Service with key officials and legislators at the state and national level. The leadership of this group has shown a keen interest in the biosphere reserve concept and the activities at the reserves at Great Smoky Mountains National Park and the Coweeta Hydrological Laboratory.

Special interest groups, particularly conservation groups, can play an important functional role in reserve activities. At the national level, organizations such as the National Parks and Conservation Association, through their support of conferences such as this and the dissemination of information to their membership, can help mobilize support for and involvement in reserve activities. At the local level, cooperating associations have great potential as a source of voluntary support for reserve programs. They also provide a mechanism for the development and distribution of publications that provide information to the public on the importance of reserves in the conservation and utilization of our natural resources.

One critical area that has not been adequately addressed is the linkage between biosphere reserves and sustainable development. This issue presents an excellent opportunity to introduce businessmen, industrialists and members of the professions to the biosphere reserve concept and its relationship to sustainable development. Too often they equate biosphere designation with "locking up" resources rather than providing the basis for effective management and appropriate utilization of these resources. There are numerous organizations that represent these groups, and they are often eager to identify new topics and speakers for their meetings. A particularly important group is the Rotary Clubs. They are especially interested in programs that have international implications. An effective presentation may enlist their active support for reserve activities, or at least enhance their understanding.

In the rest of this paper, I will review some of the mechanisms, structures, and techniques that have been used in selected biosphere reserves to coordinate and integrate activities within the reserve with those in the surrounding region. No single model will serve the needs of all biosphere reserves, since the achievement of effective regional coordination must be developed within the context of the priorities of each biosphere reserve and the capabilities and needs of people and institutions in the region. These examples will, however, hopefully provide the basis for further creative thinking on the part of managers of biosphere reserves about the concept of regional coordination and its significance for their reserves.

MAPIMI BIOSPHERE RESERVE

The Mapimi Biosphere Reserve in northwestern Mexico has developed a highly integrated model of regional involvement in the management of the reserve (Halffter, 1981; Montana, 1984). One of the keys to the success of this approach was the opportunity to involve critical constituencies in the actual planning and establishment of the reserve. These included the Governor of the state of Durango, federal agencies such as the National Council of Science and Technology and the Secretary of Public Education, representatives of the cattlemen, small land--owners, and members of the Ejido de la Flor, an organization representing groups of peasants who have received grants of land from the State to utilize as a group or as individuals. Overall coordination and planning was provided by the Institute of Ecology.

The principal economic activities in the reserve are stock-raising, subsistence agriculture, the production of vegetable wax and salt production. To ensure the cooperation of the regional constituencies in the attainment of reserve objectives, an extensive effort was made to involve the groups in the research and conservation programs of the reserve. In this way they came to appreciate the direct link between these programs and the improvement of the economic activities that sustained their livelihood.

Their participation then made it possible to gain sufficient support to establish a legally constituted association to manage the reserve. Members of the association include representatives from: the cattlemen, the small land-owners, the ejidos, the National Council of Science and Technology, the Institute of Ecology, and the MAB program in Mexico.

WATERTON LAKES NATIONAL PARK BIOSPHERE RESERVE

Unlike the Mapimi Reserve, the Waterton Lakes National Park Biosphere Reserve was established by the designation of a national park unit of Parks Canada that has been in existence since 1895. Thus a parallel opportunity to involve regional constituencies in the actual development of the Reserve did not exist. The leadership of the Reserve did recognize, however, that effective management of the Park as a Reserve would require cooperation and coordination with several other agencies and interested groups in the region. These included Glacier National Park, another designated biosphere reserve to the south, provincial forests and private ranchland to the north, and a provincial grazing reserve and more private ranchland to the east (Cowley and Lieff, 1984; Scace and Martinka, 1983).

The first step in this direction was the convening in 1981 of a workshop to examine the biosphere reserve concept in relation to the Waterton Lakes Reserve. The workshop participants, which included international experts, federal and provincial land management agencies, researchers, and local ranchers, recommended as a top priority establishment of a coordinating body at the local level.

This recommendation was implemented and a local coordinating committee was established in 1982. The Committee, whose membership included several ranchers and park staff, consulted with representatives of provincial agencies and produced a list of goals for the Waterton Lakes Biosphere Reserve (Cowley and Lieff, 1984).

In an attempt to achieve these goals, the Committee has sponsored three major programs. The first is a series of forums for information exchange. These have covered such topics as diffuse and spot knapweed control, elk management, and forest insect problems. The second is a consideration of steps that can be taken to develop reserve boundaries that will encompass more than the core National Park. The third is the establishment of a technical committee to advise on the definition and sources of support for a comprehensive research program.

MULTIPLE-SITE BIOSPHERE RESERVES - SOUTHERN APPALACHIANS

One of the first multiple-site biosphere reserves to be proposed was a single conceptual reserve for the southeastern division of the Eastern Forest Biotic Province (Franklin, 1977). As originally proposed, this reserve included a core area, the Great Smoky Mountains National Park (GRSM); two experimental biosphere reserves, the Coweeta Hydrological Laboratory (Coweeta) and the Oak Ridge National Environmental Research Park (Oak Ridge); and a buffer or manipulative zone (Johnson et al., 1979).

For a variety of reasons, only GRSM and Coweeta were designated as biosphere reserves and the buffer or manipulative zone was never defined nor its boundaries delineated. Unlike Mapimi and Waterton Lakes, no overall mechanism for regional coordination has been developed, but a number of separate but interlocking organizations and activities constitute an impressive network for regional coordination.

In an effort to improve communication between scientists working within the reserves and the surrounding uplands region, the GRSM Uplands Research Laboratory in 1975 initiated an annual meeting for reports on scientific research and monitoring. It is clear this is an important forum for communication between individual scientists working on problems of common interest.

The Southern Appalachian Research/Resource Management Cooperative (SARRMC) has also played an important role in regional coordination. This unique consortium, comprised of four federal agencies (U.S. Forest Service, U.S. Fish and Wildlife Service, National Park Service and Tennessee Valley Authority) and six universities (North Carolina State University, University of Tennessee - Knoxville, University of Georgia, Virginia Polytechnic Institute and State University, Clemson University, and Western Carolina University) was formed to improve communication between researchers and resource managers. SARRMC is a true cooperative. There is no paid staff or budget, and all activities are carried out using volunteer assistance and funds provided by the members or by small grants and contracts from other agencies and organizations. These activities have included projects on stream management, wood as an energy source, natural diversity in forest ecosystems, management of mountain balds, forest insect problems, management of wild boar populations, and assessment of damage in the spruce fir ecosystem. SARRMC also conducted for MAB an assessment and evaluation of the information base and science activities at GRSM. The project eventually involved over sixty scientists and resource managers, and resulted in the publication of two volumes, a history of scientific study in narrative and tabular form and a bibliography of over 500 references (McCrone et al. 1982a and 1982b).

Coweeta has been designated as a long-term ecological research site by the National Science Foundation, and in cooperation with the University of Georgia has carried out numerous studies relevant to the entire region. They have also collaborated with park scientists on several projects. One was a study of the influence of rooting by wild pigs (Sus scrofa) on surface fauna, nutrients, and biomass of forest litter and soil in GRSM. A retrospective symposium on fifty years of research at Coweeta was held in October, 1984.

In addition to these activities, both GRSM and Coweeta engage in a number of joint research and monitoring projects with a wide array of agencies and educational institutions. As a result, a survey designed to assess the status of the baseline resource inventory, long-term monitoring, and long-term ecological research in 14 biosphere reserves managed by the NPS showed that GRSM had high ratings in all three categories (Mack et al. 1981).

Although no formal mechanism has evolved for the involvement of local officials and the public in reserve management, a number of organizations now play or have the potential to play a key role. The park has organized periodic meetings with representatives of a number of conservation organizations. This is known as the Unity Group, and it serves as a forum for discussion and dissemination of information on national and cultural resource issues facing the park. The GRSM Natural History Association has also played an important part in the environmental education program in the park, a key objective of biosphere reserves. This organization through its assistance to park interpretive programs can also help in the dissemination of information on the nature and importance of the biosphere reserve concept.

Other organizations that have the potential to involve the public in reserve activities are such citizen groups as the North Carolina Parks, Parkway and Forests Development Council, the Tennessee Park Commission, Western North Carolina Tomorrow and the Western North Carolina Associated Communities.

It would appear that advocates of the biosphere reserve approach to resource management in the Southern Appalachians face a critical issue. Should they use more effectively the existing network of organizations to enhance the implementation of the biosphere reserve concept, or should they seek a more formal and structured approach such as the establishment of a biosphere reserve advisory committee?

SOUTH ATLANTIC COASTAL PLAIN BIOSPHERE RESERVE

The designation of the South Atlantic Coastal Plain Biosphere Reserve, containing two widely geographically separated units, the Pinelands National Reserve in New Jersey and the Congaree Swamp National Monument in South Carolina, is a further extension of the multi-site biosphere reserve concept. Each unit will face two challenges, coordination within its immediate region and coordination between the two units.

The Pinelands Reserve, like the Mapimi, had active involvement of government at the local, state and federal level as well as public participation from the very beginning. Congress, when it established the reserve in 1978, mandated the creation of a planning commission that represented these interests (Hales, 1978). This Commission has developed a Comprehensive Management Plan for the Pinelands which is conceptually similar to the model for biosphere reserves designed by IUCN (Hales, 1984). In addition, this Commission has a great deal of authority to regulate land use. Thus it would appear the Commission would also be the appropriate body to assume the responsibility for management of the reserve as an international biosphere reserve.

Congaree Swamp National Monument, on the other hand, is in a position similar to Waterton Lakes and Great Smoky Mountain National Park. It can develop ways to achieve regional coordination that reflects its needs and circumstances. With respect to coordination between the two units, it is my opinion each should have maximum autonomy as biosphere reserves, but that some mechanism should be developed to enable them to identify those common activities in their reserves which would contribute to greater understanding of the biogeographic region they represent.

LESSER ANTILLES

At a workshop on biosphere reserves and other protected areas for sustainable development of small Caribbean islands, several speakers recommended that serious consideration be given to the establishment of a multiple-site biosphere reserve in the region (Wood, 1984). The Virgin Islands National Park Biosphere Reserve could be considered as the first unit, and further planning and development would be the joint responsibility of the newly-formed Virgin Islands Resource Management Cooperative (VIRMC) and the established Caribbean Conservation Association. VIRMC was developed in consultation with representatives from the Southern Appalachian Research/Resource Management Cooperative (SARRMC) and there are some similarities between the two organizations, although VIRMC has a more diverse membership than SARRMC. Included are the College of the Virgin Islands, the Virgin Islands National Park, the Virgin Islands Planning Office, the West Indies Laboratory, the U. S. Geological Survey, the Island Resources Foundation, the Eastern Caribbean Natural Area Management Program, Diversified Resources, Inc., the U. S. Fish and Wildlife Service, the Virgin Islands Department of Conservation and Cultural Affairs, the Caribbean Fishery Management Council, and the Southern Forest Experiment Station. VIRMC is already providing a vehicle for regional coordination for the Virgin Islands National Park Biosphere Reserve, and several joint projects are underway. One is an integrated, multi-year program that will provide a comprehensive description and evaluation of marine ecosystems and fisheries of the region, including nearby areas in the British Virgin Islands. This will help develop the basis for long-term monitoring to support effective management. The park is also sponsoring an annual colloquium on research in the region. It is too early to determine whether or not it will be possible for VIRMC and the Caribbean Conservation Association to develop a multiple-site biosphere reserve encompassing other islands in the Lesser Antilles, but the prospect is an exciting one.

CONCLUSIONS

The mobilization of regional constituency groups in support of the attainment of biosphere reserve objectives is valuable in several respects. It helps provide a stable political base in support of reserve activities, a network for the exchange of information, and direct functional support for research scientists, educators, volunteers, providers of technical assistance, and sources of financial support. Many biosphere reserves have developed specific structures, mechanisms, and techniques for mobilizing this support. These range from simple unilateral relationships to complex organizations integrating a number of constituencies. Each reserve must and will approach this in different ways reflecting their geographic setting, their political history, their critical management issues, and the interest and capabilities of other regional organizations.

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PUBLIC COMMUNICATION AND DEVELOPMENT OF A CONSERVATION ETHIC

© Gabriel J. Cherem[1]

Abstract. The development of a conservation ethic concerning biosphere reserves is heavily dependent upon effective, two-way human communication. Key communication concepts are outlined and applied to example messages from biosphere reserves. A communications planning process is set forth, and the concepts of communication linkages and community interpretation are cited as potentially powerful tools in the development of a conservation ethic.

Key words: biosphere reserve, communication, linkages, community interpretation.

INTRODUCTION

I prefer the term "communication" to the term "education," which appears in the conference program. To me, communication implies a two-way process of interchange, whereas too often education remains only a one-way process.

Before we can communicate about moral principles or ethics concerning conservation in general and biosphere reserves in particular, we must take a closer look at key human communication concepts. What concepts have the greatest chance of producing quality human communication?

KEY COMMUNICATION CONCEPTS

"Treat me as an equal, and as a person with many facets." As an example of this, I am speaking to you from three separate roles today: as a businessperson, as an academic, and as a layman. (I continually find the layman's viewpoint of matters to be a major source of my understanding of effective human communication.)

As a layman, to be involved in truly effective communication, a message must relate to my everyday life, be provocative of my attention, and should be connected to a higher level context in my own life. The communication process must get me actively involved in the message, must touch my emotions, and must motivate me to further exploration or action. (Not coincidentally, these are some of the classic interpretive principles set down by Freeman Tilden. In a broader sense, these interpretive principles are also powerful principles of effective communication.)

If the message is effective, I in turn will communicate back to the message's sender, and perhaps more importantly, will communicate that message enthusiastically to my friends and neighbors.

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Word-of-mouth information networks are the most powerful form of human communication. If these networks start with a clear, positive, and relevant message---they result in a clear, positive, and relevant message being passed on to others. If a word-of-mouth network starts with an unclear, irrelevant, and thereby negative message, the opposite effect will occur.

As a businessperson, I am learning that, at root, communication is a matter of perception. Two important elements of perception are identity and image. Identity is what you are; image is how you are perceived. Ideally, both identity and image should be . . . and should be effectively communicated and thereby perceived . . . in harmony.

Those of us assembled at the Conference on the Management of Biosphere Reserves know what a "biosphere reserve" is (identity), though I must admit it did take me awhile to grasp this rather abstract concept. For many laymen, however, hearing the term biosphere reserve creates a heavy fog in the mind---and unclear, confusing, and potentially frustrating mental images.

If we want the biosphere reserve concept to become understood, utilized and perceived as a wise use moral principle, we need to re-image the concept for the layperson in a way that accurately reflects and maintains the identity of the concept.

I do not have a ready answer for precisely what this new and understandable image should be. This imaging process will and should take time and a good deal of effort. I do know that what we have here is a classic problem of many businesses---portraying a clear and well-thought-out image that accurately reflects a well-thought-out identity.

UNIQUE MESSAGES TO CONVEY IN BIOSPHERE RESERVES

From the standpoint of an academic versed in understanding and teaching ecological subject matter, communications, and human behavior, it is apparent that the biosphere reserve concept embodies many exciting ecological and conservation messages. The quality of the communication of these messages will determine to a great extent the way in which they are imaged, valued, and acted upon by the layman in terms of a conservation ethic.

The "global significance of biota" is a vital ecological concept . . . but from the view of the layman . . . who cares? I can't understand it, much less act on it. To me it sounds like another example of esoteric gobbledegook. However, imaging of the concept as "our community is unique on the face of the earth!" is immediately more provocative, and brings the concept closer to home . . . it is our community. It is a source of our local pride. Members of my community are then in a better position to understand the concept, and it is only a small step to linking the unique local human community to the concept of a unique natural community nearby. The survival of both communities is inextricably married.

The "value of genetic diversity" can be another example of meaningless gobbledegook to local citizens . . . who cares? However, the popular and imageable phrase in North American culture, "don't put all your eggs in one basket," begins to communicate the concept much better. We need "many baskets" . . . containing many sizes and colors of eggs (genes) . . . in order to strengthen our chances for survival and our opportunities for growth. If one basket is destroyed or damaged by a barnyard pest, we still have wisely stored other baskets in other places (biosphere reserves) to ensure our survival.

COMMUNICATIONS PLANNING

Communications planning is a relatively new but extremely powerful process. It allows us to generate and organize a tapestry of interrelated messages we wish to communicate; encourages us to analyze and understand the needs and interests of diverse target groups; forces us to analyze the emotional and sensory mental imagery and experience of the target groups; and enables us to happily "marry" message with target group through powerful and precisely-chosen methods of communication.

The tapestry of messages we can communicate includes an organizational system of themes, subthemes, concepts, and experiences. This tapestry can and should be generated and organized on at least a national level for the biosphere reserves program. Each individual biosphere reserve, then, needs a similar tapestry generated and organized; and each reserve's tapestry must be internally consistent with the national one and with other reserves. This process allows us to focus in on particular problems and opportunities at any one reserve.

As an example, having accomplished this organizational process, we may determine that a key message to communicate at a particular reserve is the value of cooperation in the monitoring of a forest insect pest. The outbreak of the pest may likely be handled in two ways---more aggressively on surrounding community lands, and more passively (because of preservation mandates) in a biosphere reserve core unit. Even though the problem may be handled differently, there is a distinct opportunity for groups to work together to obtain a better understanding of the problem and its control. Through cooperation and monitoring of various artificial and natural control measures, the best blend of these two methods may be isolated.

We must then look at potential target groups for this message and process of cooperative monitoring and insect control. The local forest industry is going to have needs and interests in immediate control; local farmers will not necessarily be as upset by the problem; and local merchants may not at first be aware of how the forest insect problem may hurt them due to decreased recreation opportunities. Each of these target groups will require a decidedly different approach in our communication of the message to them. Further, the farmers and merchants may turn out to be an excellent avenue of informal community liaison to the forest industry, as the insect problem does not present as clear a perceived threat to them.

We must then analyze the emotional mental imagery of each target group---as an example, the forest industry. Their immediate mental images may consist of the biosphere reserve core unit employees and policy as distinct and concrete threats to the industry's livelihood. This false image must be overcome by providing positive and genuine examples of the core unit's employees actively attempting to work with the forest industry in grappling with the insect pest problem. Concrete images of core unit employees calling, writing, and most importantly, visiting forest industry representatives are certain to help create a less adversarial mental image in the minds of the forest industry people.

We have already hinted at the communication methods to best convey both the reality and mental image of cooperation. Depending upon the size and value system of the community involved, informal personal visits, informal conversations in local establishments, supportive telephone calls, or official letters inviting cooperation may be chosen. Very likely a combination of methods is most appropriate to use.

A key term to remember here is that of "linkages." The more active and sympathetic linkages we can make between people, between organizations, and between people and organizations, the better chance we have of sharing our expertise and experience in accomplishing a joint goal.

COMMUNITY INTERPRETATION

It is precisely this concept of "linkages" that we have found to be the mainstay of the community interpretation process that we have been developing over the past four years. Community interpretation is the telling of the stories of a community to its residents and visitors. It involves not only linking people and organizations together, but also the linking of a story to the imagery in an individual's mind.

Having gained experience in the application of the community interpretation process in Rochester, New York; Chelsea, Michigan; and the Hawaiian Islands, we have gained a new appreciation for the power of the linkage concept. When presented with an opportunity or confronted with a problem of common concern---if that common concern is imaged and facilitated accurately and properly---people and organizations have been more than willing to become involved in cooperative group efforts.

The linkage between biosphere reserve core areas and their local communities is absolutely essential to the furtherance and valuing of the biosphere reserve concept. Further, the linkage of how the biosphere reserve concept is relevant to the everyday lives of local citizens must be made aggressively by people who are committed and sensitive to the way that the human communication process works.

COMMUNICATING WITH VISITORS

If a visitor to a biosphere reserve area can see that local citizens are enthused by and proud of their biosphere reserve, that visitor is more likely to find the concept relevant and interesting. Essentially, then, "getting your act together" locally may be the most critical step in the process of communication toward a conservation ethic.

The visitor will definitely talk to local citizens, may read local newspapers, listen to local radio, and view local television. The visitor may also spend some time at your visitor center, and partake of your site programs.

If biosphere reserve messages have been organized, targeted, and communicated relevantly and enthusiastically at the local level, all of the above media will in turn convey those messages and image to visitors. If local communication has been ineffectual, or even conflicting and controversial, then <u>that</u> image will be conveyed to visitors.

Biosphere reserve messages can and should be communicated strongly through visitor centers and other on-site programming. Realize though, that your on-site communication will represent a <u>relatively small portion</u> of the visitor's experience in your locality.

Attempting to communicate complex biosphere reserve messages totally on-site is akin to the proverbial "bandage on the amputee." Ongoing and positive communication linkages with the local community, and community support for biosphere reserve concepts, are the keys to visitor understanding and appreciation of those concepts.

OBJECTIVES AND NATURE OF SCIENTIFIC PROGRAMS IN BIOSPHERE RESERVES

Jerry F. Franklin[1]

Abstract.--Three categories of research appropriate to biosphere reserves (reserve-management, natural-baseline, and resource-management) are discussed, as well as the success of the MAB program in stimulating such activities. The potential for collaborative research between paired reserves has not been realized. Technical considerations in research and monitoring programs are also discussed, including the importance of long-term and interdisciplinary studies and of data management.

Key words: baselines, natural areas, long-term research, ecosystem research, data management, inventory.

Research is a key characteristic distinguishing the Biosphere Reserve (BR) Program from many other conservation efforts. As early as the meeting of the Man and the Biosphere (MAB) "Task Force on Criteria and Guidelines for the Choice and Establishment of Biosphere Reserves" in May 1974, it was determined that one of the three purposes or objectives of BR would be "to provide areas for ecological and environmental research." Furthermore, research that would make a contribution to "the theoretical and practical aspects of conservation and natural resources management" was to be a part of the scientific program in addition to research essential to management of the reserves (UNESCO 1974).

The concept of BR as sites for research relevant to resource management and solution of related societal problems has both distinguished the program and made it attractive to many developing nations. Demonstration and educational projects were viewed as a logical extension of this research. Various strategies for integrating the preservation objectives of BR with intensive research programs were proposed, including the use of core areas with strict conservation objectives surrounded by buffer zones where manipulative research and various consumptive land uses could be carried out.

The United States MAB Committee on Project 8 (Biosphere Reserves) developed the concept of paired reserves in the biotic provinces of the United States (Franklin 1977). This concept recognized that it was seldom possible to identify a single area that satisfies all criteria--a large, strictly preserved tract for conservation of a full array of organisms, with a substantial history of research and monitoring and potential for major experimental treatments. The outstanding conservation areas in the United States are typically either national parks or wilderness areas and have limited research histories and potential for experimentation. Many of the outstanding ecological research sites are, on the other hand, U.S. Department of Agriculture Forest Service and Agricultural Research Service Experimental Forests and Ranges and Experiment Stations. Collaborative, MAB-oriented research programs were to be developed between the

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conservation and experimental elements of the BR cluster established in each of the biotic provinces.

Broadly-based research programs have, therefore, been a basic element of the BR program from its initiation. Three important categories of research appropriate to BR-- reserve-management, natural-baseline, and resource-management research-- are identified in this paper and illustrated with examples. Successes and falures in achieving the original concept are reviewed. In addition, technical considerations for BR research and monitoring programs, such as the importance of holistic and interdisciplinary projects, long-term commitments, collaboration between BR, data management, and varied logistical support are given. The paper concludes with a discussion of the critical need for agency support in developing the necessary programs.

SCIENTIFIC PROGRAMS IN BIOSPHERE RESERVES

If we look at BR in the context of a regional resource with broad objectives of improving resource management and conservation within a biotic province, three categories of research and monitoring seem apparent. These are: (1) reserve-management research designed to help fulfill the conservation objectives of BR; (2) natural-baseline research designed to provide baseline and other information on natural ecosystems for use either outside or within a BR; and (3) resource-management or land-use research to provide information on management of natural resources for consumptive uses.

Reserve-Management Research

Reserve-management research is related specifically to the management needs of the BR, providing information needed to achieve its conservation objectives. On properties such as the national parks and wilderness, this research usually relates to preserving the diversity and integrity of natural ecosystems and processes, to maintaining populations of specific species, and, in some cases, to restoring natural conditions.

Most of us are familiar with this category of research, which is typically oriented toward problem-solving. There are many examples. Such projects characterize the research programs supported by the National Park Service (U.S. Department of the Interior). Studies of fire ecology (including natural fire regimes and prescribed burning), structure and dynamics of animal and plant populations, and control of introduced species are typical. Such projects have relevance to other ecosystems and resource-management programs in a biotic province. The primary objective of this research, however, is the solution of management problems within the BR.

Natural-Baseline Research

Use of BR for natural baselines can take two major forms: first, surveys, research projects, and monitoring programs to provide information on the status and trends of ecosystem processes, organisms, or elements, including pollutants; and second, as sites for studying ecosystems and landscapes to provide information on natural processes, structures, and especially, linkages between landscapes and ecosystem components.

BR are already undergoing extensive use as ecological baselines. A program for monitoring pollutants in the soil, water, vegetation and atmosphere was developed by

Wiersma and his associates (Wiersma et al. 1978). This program has been implemented at Olympic, Great Smoky Mountains, Glacier, and, on a preliminary basis, Sequoia-Kings Canyon BR, providing information on regional background levels of various organic and inorganic pollutants.

BR are also being used as sites for studying undisturbed ecosystems as well as the ecology of natural populations of specific organisms. The information from such studies contributes to the basic scientific understanding of the natural resources of a biotic province and sometimes proves immediately relevant to resource-management problems.

A study of the alluvial forest ecosystems of the Hoh River Valley in the Olympic BR exemplifies the practical value of such research (Franklin 1981, Starkey et al. 1982). A significant discovery was the importance of tributaries--side channels and terrace streams--to the main river channel; over 90 percent of the fish production, which included several anadromous species, was associated with these habitats that had previously been ignored by forestry and fisheries managers elsewhere in the biotic province. The Hoh River research also provided a natural baseline for fine sediments in spawning gravels; this was applicable as a standard for levels of silt tolerable to spawning anadromous fish in rivers outside the reserve.

Natural-baseline research inevitably serves both the BR and natural resources in the biotic province at large. Any studies that elucidate the current status or trends in pollutants, for example, assist in identifying potential management problems. Similarly, expanded knowledge of ecosystem structure and behavior or of the ecology of species will typically prove useful in the management of a BR, even if it is currently unrelated to a recognized management problem.

Natural-baseline and reserve-management research may overlap substantially. Monitoring of natural populations or ecosystem processes may, for example, be essential parts of reserve-management programs. Problem-oriented baseline programs can contribute significantly to the basic understanding of ecological processes within biotic provinces. The acid precipitation studies being established in several of the national parks provide excellent examples; baseline information essential to park management programs is being obtained simultaneously with knowledge of ecosystem composition, structure, and function.

The large conservation reserves provide some unique and critical research opportunities for their biotic provinces (Franklin 1981). These include the opportunities to study (1) large, natural landscapes and drainage basins, (2) populations of large animals, including ungulates and predators, and (3) large-scale patterns of natural disturbances, as well as (4) serving as baselines for pollutant levels. National parks are superior to wilderness areas under the jurisdiction of the Forest Service, Bureau of Land Management, or the Fish and Wildlife Service for most of these purposes because there are fewer unnatural influences, such as hunting and grazing, within the national parks.

Resource-Management Research

There is a large and continuing need for research on the development and evaluation of methods for consumptive use and management of natural resources within biotic provinces. BR were intended to contribute to such research. Research on management of timber, forage, wildlife and fisheries resources is appropriate, as is rehabilitation of

lands adversely affected by extractive processes such as mining. In some biotic provinces, the development of ecologically sound agricultural systems is a logical topic for research programs.

A major element of MAB-related research is the development of technologies that permit resource utilization consistent with the maintenance of the ecological integrity of the biotic province. Strategies for production of multiple goods and services, such as timber and water or agriculture and wildlife, are clearly high priority. Such research typically relies on experimentation, often at the level of watersheds.

Examples of such research are common in the series of experimental forests and ranges and experiment stations that are a part of the U.S. BR system. The research includes studies of the effects of timber management practices on water yields, erosion, and water quality; effects of alternative silvicultural systems on regeneration and growth of various timber types; evaluation of alternative grazing systems for production of domestic livestock and wildlife; and effects of various management practices on the soil properties and long-term productivity of the land.

SUCCESSES AND FAILURES IN THE U.S. BIOSPHERE RESERVE PROGRAM

All three types of research are being done to at least some degree in the U.S. BR, but rarely because of their BR status. Most have viable research programs, as would be expected of areas that are the outstanding natural landscapes (national parks) and the outstanding sites for natural resources experimentation (experimental forests and ranges) in the United States. These programs have expanded during their tenure as BR, but the emphases in the new and expanded programs have generally not reflected their importance as part of this world system or the particular goals of the Bisophere Reserve Program. Nor have they reflected the cluster concept as discussed below.

Several U.S. BR are receiving major research support after successfully competing in the National Science Foundation's Long-Term Ecological Research (LTER) program. In fact, six of eleven selected LTER sites---H. J. Andrews, Central Plains, Coweeta, Jornada, Konza Prairie, and Niwot Ridge---are BR. This provides support for long-term observations and experiments at these sites, contributing to all three categories of research.

As mentioned earlier, several other U.S. BR have been selected as sites in the National Park Service's acid deposition research program. These are currently Olympic, Rocky Mountain, and Sequoia-Kings Canyon. While intended primarily as reserve-management research (identifying threats to and impacts on park resources), this program also produces natural-baseline data for their biotic provinces.

Some collaboration is taking place between core and experimental BR within some of the biotic provinces. Joint studies have been made between Olympic and Cascade Head BR in the Oregonian Province and between H. J. Andrews and Three Sisters BR in the Sierra-Cascade Province. Collaborations are also developing between Coweeta and Great Smoky Mountains BR in the Eastern Forest Province; this cooperation may extend to the Hubbard Brook BR and the Oak Ridge National Environmental Research Park, the latter an outstanding experimental area for which the Department of Energy continues to refuse BR status.

The potential of the paired or cluster concept of the U.S. BR system is largely undeveloped. This is extremely unfortunate for the progress of ecological science in these provinces. Comprehensive research programs have to address both preservation of the natural diversity- genetic, specific, and ecosystem- -and the sustained, balanced use of natural resources. Balanced research and educational efforts similarly must consider jointly the preservation and conservative use of a province's natural resources. Collaborative efforts between research sites and staffs with these complimentary perspectives would contribute significantly to faster advancement toward these goals.

The concept of paired BR was also designed to provide for varied research within a unified research theme. The national parks provide some unique opportunities, as mentioned earlier, including research on essentially natural populations of larger, wide-ranging ungulates and predators. The experimental areas, on the other hand, provide sites where manipulative experiments are possible for both elucidating ecological principles and testing various management concepts. Taken together, a fuller range of research and staff is possible, along with greater overall relevance to human societal objectives and needs.

Overall, the failure to recognize the potential in the BR system appears to be largely institutional. Agencies managing these areas have limited funds and their own priorities for the use of resources. These only occasionally converge with those of the MAB program. The National Park Service has worked hardest at using its resources to meet both internal and MAB objectives. Individual scientists and agencies funding scientific programs probably merit criticism for not making maximum use of BR in programs. It is critical that these sites play their appropriate roles in the developing acid rain research programs. The Department of Energy and the Environmental Protection Agency should extensively utilize BR in their watershed--level research efforts; hopefully, they will.

An obvious problem is the lack of incentives for research collaboration among the BR in a province. Given agency imperatives and budgeting procedures, neither scientists nor research managers are encouraged to cooperate. Some incentives need to be developed to stimulate agencies (on the larger scale) and BR (on the provincial scale) to develop collaborative efforts on issues of common interest.

TECHNICAL CONSIDERATIONS IN RESEARCH AND MONITORING

Points requiring emphasis in the development of research and monitoring programs in BR are the need for:

- Long-term versus short-term studies.
- Holistic versus organismic studies.
- Comparative studies and networking.
- Inventories.
- Data management.
- Facilitation and logistical support of scientific efforts.

These are important considerations in all three types of research as well as in the educational aspects of the BR programs.

Long-Term Perspective

Long-term programs of research and monitoring must be emphasized in BR. It is increasingly apparent that long-term data bases are essential to the resolution of many issues in both applied and basic research and in the identification of developing problems, such as effects of pollutants (Likens 1983). Long-term experiments and monitoring are needed to provide critical tests of hypotheses, measure rates of long-term processes, provide baselines and illustrate trends, and identify and provide information on episodic phenomena.

There are numerous illustrations of the importance of long-term data in ecological and resource-management research. For example, important episodic phenomena, such as freeze damage to saguaro cactus and reproductive patterns of coast redwood or southwestern ponderosa pine, only emerge from such data sets. Important ecosystem phenomena, such as the effects of insect defoliation on nutrient cycles (Swank and others 1981) or impacts on water yields when converting forests from deciduous hardwoods to conifers (Swank and Douglass 1974), can often be seen only in the context of a long-term baseline.

A commitment to long-term research and monitoring also means a significant commitment to field installations. It means long-term experiments involving manipulations of ecosystems along with necessary instrumentation, often in the form of water measuring and sampling facilities. It means permanent sample plots with sufficient marking for their relocation and, often, identification of individual points or organisms. It means establishment and maintenance of exclosures with adequate preinstallation measurements and statistically sound designs. It means commitment to collecting environmental and population baselines in which the initial instrumentation or measurement is only the beginning of an extensive data collection and analysis process. Continuity of measurements is absolutely critical, and it is an institutional responsibility to perpetuate such programs through times of fiscal austerity and personnel changes.

Modern tools, such as remote sensing techniques, can assist in efficient development of these long-term data bases, but they cannot substitute for on-the-ground efforts. There is no easy way to accomplish these goals, nor is there any substitute for thorough knowledge of the natural history of the ecosystems and organisms of interest. The marine monitoring program at Channel Islands BR illustrates the excellent achievements that are possible when thorough biological knowledge is structured in sound statistical designs to achieve well-defined objectives.

Holistic Perspective

Research in BR should emphasize a holistic, ecosystem perspective and the use of interdisciplinary research teams. Most of the important ecological discoveries of the last 15 years have been the result of research projects, such as the International Biological Program, that approached ecosystems in their totality. Examples include recognition of the rapid turnover and high energy requirements of roots and associated below-ground plant parts; the importance of vegetative regrowth in minimizing nutrient losses following disturbance; the importance of canopy-atmosphere interactions in cycling of various substances; the importance of coarse woody debris in forests and streams; and multiple pathways for nitrogen fixation in forest ecosystems.

Holisitic, interdisciplinary research efforts have special significance in BR programs because most of today's important resource-management problems are interdisciplinary. Research on the importance of old-growth forests, effects of acid rain, cumulative effects of manipulation of landscapes, effects of management on long-term site productivity, control of introduced plants, and management of fisheries are simply not susceptible to individual scientific efforts. Furthermore, many of these problems have sociologic and economic dimensions that must be considered along with the ecologic considerations. Scientists associated as agency personnel with a specific BR have a particular responsibility in stimulating research projects and in providing scientific syntheses that have a whole-system perspective.

Comparative Studies and Networking

Collaborations between BR, both within and between provinces, are another important concern. Comparative studies are essential to develop broad patterns in the structure, function, and management responses of ecological systems. Ecosystems exhibit gradients in the types and importance of various processes both between and within a province. MacMahon (1981) illustrates broad patterns of this type in his comparison of successional processes across the spectrum from desert to rain forest. A localized example is the contrast in rates and causes of tree mortality within the coniferous forests of the Pacific Northwest (Franklin et al. 1985). Comparative efforts will clearly be required to place local studies in the regional, national, and world context.

Development of and participation in national and international networks is a systematic approach to comparative research. Several programs of this type have been developed or proposed, including the National Atmospheric Deposition Program, the Global Environmental Monitoring System, and the Integrated Global Background Monitoring Network proposed by Wiersma (1984). Programs of this type are extremely important both in linking BR and in developing broad perspectives on important problems. More limited collaborative experiments or studies are also important, however, as illustrated by a proposal for the exchange of wood samples in a reciprocal study of the rates of wood decay between H. J. Andrews and Coweeta BR.

BR can and should also associate themselves in more loosely structured comparative efforts. Sampling protocols can be established for the collection of meteorological data, design and measurement of permanent sample plots and transects, animal censusing, and monitoring of ecological processes, such as litterfall. Standardized procedures would facilitate comparative analyses and exchange of information between BR. An example is the use of common procedures to establish permanent forest sample plots in the Pacific Northwest and the southern Appalachians.

Inventories

Inventories of the physical and biological resources of a BR are essential to any research and education program. I have not emphasized this particular activity because many U.S. BR are rapidly improving their inventory base. Inventory takes many diverse forms, from geologic and topographic mapping, to periodic aerial photo coverage, to preparation of checklists for individual groups of organisms.

There are a number of documents available that outline the types of inventory data important in BR. Three general comments concern prioritizing, availability, and

bootlegging of inventories. Regarding the first, most of us have been involved in preparing lists of parameters for inventory. The listings invariably exceed any forseeable inventory resources. Some types of inventory, such as aerial photo coverage, are so fundamental and have such wide application that they must be given funding priority. Second, inventories must be generally available to scientists and managers. This may be in the form of computerized data sets, or as publications; the printed page still has great value, as illustrated by bibliographic listings (for example, Gaskin and others 1984) and annotated checklists of organisms (for example, Voegtlin 1982). Third, inventories will have to be accomplished as parts of other research or management programs. For example, major inventory needs in BR are often for lower organisms, such as lichens and fungi, and for many groups of invertebrates. Support for surveys of such organisms has been hard to obtain despite their critical importance in many ecosystem processes. Scientists and managers need to link these inventories to more popular programs. Such linkage with functional research or management projects may actually be a preferred approach, as it will help to keep inventories timely and focused.

Geographically-oriented inventories are increasingly important, and many computer-based approaches exist. Some techniques effectively use sample-based models to generate landscape-level ecological data based on topographic maps (Kessel 1979).

Documentation and Data Management

An emphasis on long-term research necessitates a substantial commitment in BR programs to all aspects of data management. This includes thorough documentation of the procedures used in the research and monitoring programs and reduction and archiving of data sets. Data must be available to scientists and managers in a clean form and at the appropriate level of resolution. Financial resources and dedicated personnel are essential; useful guidelines for the management of ecological data sets are available, most recently from the symposium held in South Carolina in November, 1984.

Adequate documentation of locations of field installations and marking of individual plots and organisms is an essential part of the documentation job. It is rarely done adequately.

Facilities and Logistical Support

Research and monitoring programs require support in a variety of forms if they are to develop and prosper. These include facilities for living and working, and logistical support and data bases. Most BR provide some living facilities, but they are rarely adequate. Working facilities should include provision of common scientific instruments, such as balances and drying ovens, as well as space for sample preparation, specimen identification, and other activities. Computer capabilities and working libraries and specimen collections need to be available to scientific groups at a BR. Most scientists and scientific programs will require data sets from the reserve's archives; providing such data quickly and in commonly required formats should be a part of the data management program at each reserve.

Many BR managers do appreciate the important role that logistical support, in its varied forms, plays in attracting and developing major research and monitoring programs. Witness the establishment of the Uplands Field Research Laboratory at

Great Smoky Mountains BR and the rapid development of programs at Sequoia-Kings Canyon BR. All things being equal, and sometimes even unequal, scientists will tend to go where their work is facilitated and appreciated.

CONCLUSIONS

Research and educational programs oriented toward both ecological preservation and resource utilization are objectives of the BR program. Implications include the use of "core" reserves for research and monitoring programs relevant to information needs elsewhere in the biotic province, rather than simply for research needed to manage the core reserve. Also implied is the design of collaborative research programs among BR within a biotic province. Many relevant activities are underway in U.S. BR, but few are a consequence of the MAB program or reserve status. Collaborative efforts among BR clusters are very limited.

Research programs in almost all BR require expansion. These programs should emphasize long-term perspectives; holistic, interdisciplinary approaches; collaborations in comparative studies and in national and international monitoring networks; completion of inventories; and cooperation with other reserves in the biotic province in developing MAB-oriented research and educational programs. Data management should receive increased emphasis. BR managers can strongly encourage appropriate scientific use by providing logistical support and exhibiting positive attitudes.

Agency support is absolutely critical in attaining MAB objectives for BR. Institutional nurturing of such programs through financial and personnel incentives is one example; institutional commitments to the stability of long-term research and monitoring programs is another. Such commitments appear to have been more common early in the history of the Forest Service and Park Service and need to be reaffirmed.

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RESOURCE MANAGEMENT IN BIOSPHERE RESERVES

Roland H. Wauer[1]

Abstract. Resource management is defined as any activity related to maintaining or achieving a given ecological condition in accordance to the area's management objectives. It involves a systematic process of resource protection that includes planning, research, monitoring, interpretation, and implementation. Each part is interrelated and must benefit the natural and human landscapes therein. Specific ideas are included for use in developing a comprehensive resource management program within the biosphere reserve zone of influence.

Key words: Biosphere reserve, implementation, interrelationships, management objectives, neighbors, resource management, techniques, zone of cooperation.

We have so far heard a good deal at this conference about biosphere reserves in concept and in practice (Eidsvik, this conference), their role in the United States (Gregg, this conference), objectives and nature of scientific programs (Franklin, this conference), and public communications and development of a conservation ethic (Cherem, this conference). The speakers have drawn from their own experience and knowledge and from the available literature in discussing their areas of interest. And some have incorporated management responsibilities within their presentations. It is this area where I want to place my emphasis, because the success or failure of the biosphere reserve concept is directly related to the collective efforts that biosphere reserve managers provide to this program.

It is well understood in this country, particularly within the governmental workforce, that successful programs are largely the result of independent and aggressive individuals, often in spite of organizational constraints. I believe that it is essential that American and Canadian area managers take the leadership role in developing the biosphere reserve concept. The need of this leadership was emphasized by our European colleagues at a 1983 International Working Conference in the Federal Republic of Germany. The message received was that "European countries expect and want America to take the lead in resource protection on a worldwide scale. The amount of protection that European countries provide their (own) natural and cultural resources is directly related to examples provided by America" (Wauer, 1983). We, in this and in other developed countries, have an unwritten obligation to carry the banner of resource management.

What do we mean by "resource management?" How does it apply to the biosphere reserve concept?

First and foremost, it is a systematic process of resource protection. It incorporates all the pieces of a multidisciplinary matrix into a comprehensive perspective for the long-term perpetuation of an area's natural systems. It is more than planning and implementation. It also involves the activities of interpretation, monitoring and research. It can be defined as any activity related to maintaining or achieving a given ecological condition in accordance to the area's management objectives.

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Management Objectives

Logicians tell us that when we want to solve a problem we should begin with the thinking process. Otherwise we are apt to go off on another pathway entirely. It is a little like a group of blind men assigned the task of describing an elephant. Locating each man at a different part of the elephantine body is sure to create misunderstandings and divergent perceptions. It is crucial to the success of a project that each participant perceive all of the pieces similarly, and each reach the same or compatible conclusions. The initial step to assure compatibility in the case of biosphere reserves starts with the development of area management objectives that are based upon legislation and other mandates.

It is not enough for the manager to understand only the mandates of the agency, he must also understand the intended functions of the biosphere reserve. Gregg (1984) listed five of these -- conservation, monitoring, research, education and cooperation -- and stated that "the success of a reserve is determined largely on the basis of how effectively they are integrated to improve the health of a region's ecosystem and the well-being of its people."

I have incorporated these five functions into six natural resource management objectives that can be used for biosphere reserves; they are appended to this paper in the conference proceedings.

DISCUSSION

Management objectives provide that essential skeletal outline of which a program of resource protection can be built. The objectives serve as guideposts for a direction that must encompass numerous pieces of a matrix that involve both the realities of the individual management unit, including its neighbors, as well as the constraints imposed by organizational and national factors.

All of the parks and other protected lands, no matter their size, location, or purpose, continue after their establishment and dedication to be an integral part of the region's natural and human landscapes. Establishing area boundaries in themselves changes very little. Although the new reserve may subject people to new laws and regulations, we and our neighbors are still regulated by the productivity of all the land, interchange with our families and neighbors, and a myriad of other direct and indirect influences affecting our daily activities.

For the most part, those influences that have major impacts upon park or forest values also affect our neighbors and the environment in which we jointly rely upon for our existence. The magnitude of airborne pollutants, the intrusion of non-native animals and plants, and all of the known and unknown threats can impair the natural systems on which we all depend. And when we look around us to determine from whence the threats evolve, we find that the polluters of the air, the water and our land are often our nearest neighbors.

The biosphere reserve concept that has evolved from the Man And the Biosphere Program is designed to address this concern head-on. It is designed to evoke greater unity between peoples on both sides of the boundaries for their mutual well-being. It involves a much broader area of involvement than before. It recognizes a naturally regulated core area that provides a life-support system that benefits a large surrounding area of influence. That core area, whether it is a national park or equivalent reserve, when kept relatively free from major impacts to the principal pieces of the fabric, provides such free services as maintaining the quality of the atmosphere, soils and fresh water, providing pollinators and nutrients for crops, helping to control pests and vectors of diseases, as well as those values of recreation, aesthetics and spirituality. Myers (1972) got to the heart of the matter when he said, "The worlds on both sides of the park boundary would get along better if there were a clear indication of what each can do for the other. By contrast, if they spend their energy resisting one another, there is little doubt as to which must be the ultimate 'winner'."

The best method of resolving problems is by making everyone part of the process. People working together to solve a problem and equipped with all the facts will most often respond in favor of their long-term well-being. In cases when this method does not work satisfactorily, minds are more often changed by friends than they are by antagonists. Cooperation is not a one-way road, but a mutual effort directed toward a state of harmony between man and the land. The preferred result is true conservation that might be defined as intelligent cooperation with nature.

Gregg (1984) pointed out the importance of including traditional land use practices within the biosphere reserve to illustrate harmonious relationships between indigenous populations and the environment. This idea already is incorporated within many of America's national parks, and is most conspicuous within designated "historic districts." The expansion of this concept to outside of the park boundary to throughout a zone of cooperation has major implications that should be considered within the context of both resource maintenance and interpretation. Consider expanding an historic district to outside of the park unit throughout the zone of influence. And consider this zone one in which we provide various types of resource maintenance that is determined to be mutually beneficial.

An example of this cooperative spirit might relate to the control of exotic plants that impact upon both the park values and the economic interests of a neighbor. Agency efforts to control kudzu in the east or tamarisk in the southwest would have considerable benefit to both the park and its neighbors. This activity might be made part of an agreement with the county or state that incorporates certain control efforts in exchange for certain concessions of our neighbors that would provide for greater protection to the park resources.

Hoose (1981) wrote that "More elements of natural diversity are destroyed through ignorance than through malice. Nearly everyone has heard horror stories about a habitat that was destroyed deliberately by landowners wishing to avoid property restrictions . . . We don't hear as much about the habitats that are destroyed every day by people who might well have adjusted their plans had they known that something special occurred on their property."

Where do we start? How can better information be effected to minimize the losses? The answer, or at least a good part of the answer, is readily available. The National Park Service already has developed an excellent system of public education. We have over the years expanded our system of interpretation so that the public's acceptance of almost everything we do is directly related. Our interpretive methods and techniques have been copied worldwide. But we have seriously damaged this system in recent years. Interpretation has taken the brunt of budget cutbacks time and time again. Although yearly reductions did not create an immediate disaster, our actions have now caught up with us and our natural and cultural resources are suffering most.

We cannot continue to strangle the park's principal method of communications with our neighbors without misunderstandings and increasing abuse of our landscapes and the values for which the park were established to preserve. I believe that the increased negative attitudes that land managers have received from our publics in recent years are directly related to the degradation of our interpretive programs. Stewart L. Udall (1963) said that, "Conservation begins with education, and past experience makes it plain that public men will not lead unless a conservation conscience is developed which prizes the choice things of nature."

Biosphere reserve interpretation should be premier examples of this function. It must perform a dual role. One role is that of effective education to enhance a visitor's understanding and appreciation of the park or forest, including its area of wilderness and all of the ecosystem interactions. A second role, and one that is just as important within the biosphere reserve perspective, is the outreach program that deals with education outside of the park or forest. Although managers usually communicate, and usually very effectively with local businesses and the media, a constant and wide based communcations network is necessary to reach all of the publics. Gregg and Zube (1984) stated that "Public communications in biosphere reserves should have a strong focus on the interrelationships and interdependence between human beings and natural ecosystems. Programs should encourage people to think about how the quality of the earth's ecosystems is affecting their lives and the lives of people around the world."

The most effective outreach program is one that includes demonstrations and provides some extension services on problems and solutions, one that utilizes the information obtained by the research and monitoring activities, and includes policy and legal implications. Houston (1971), in discussing this issue, stated that "The interpretation of ecosystems to park visitors" (and park neighbors) "provides an opportunity to contribute to an environmental ethic that extends beyond the park environment."

It is the associated research and monitoring activities that provide the most likely pathway to ecosystem restoration and stability. Without it we will be unable to reassemble missing pieces of our ecosystem puzzle. We could not predict how a disturbance at one level of a system would affect the system as a whole unless we understood how the communities are organized biologically--how each part of the system interrelates--and when and what change occurs.

The research function is implicit with biosphere reserves, and must be integrated within the foundation of all the other activities. Baseline and ecosystem process information are equally important to permit the manager to predict the effects of any disturbance upon the system as a whole. Geist (1982) said that "No impediment . . . is greater than ignorance, it defeats the best of good will, courage, and skills."

Most good research is a result of a multidisciplinary approach. It stands to reason that understanding a species, habitat or community requires an array of knowledge that few individuals possess. Even our best ecologists depend upon others to supply them with parts of the answer. Our best scientists understand this and utilize the systems approach.

We managers tend to want to resolve a critical issue too often by considering only the most relevant details, even when those details depend upon a lower level of unavailable data. It is vitally important that we accept the fact that baseline inventories are vital to the intelligent management of our resources, and we therefore give higher priority to those surveys and inventories that we just never seem to have funds and time to start.

Research undertaken to address specific issues too often can produce randomized results that lead us in either split directions or over very shaky ground. Although good scientific interpolation may produce the correct answers, this method can fail us in court. To paraphrase Durward Allen, we must be correct the first time, and no one yet has found a better way to be sure of that than through good research.

Just as important as baseline data at the other extreme, is the need for long-term research to examine issues of longer duration. Research based on one season or one species may not provide the data necessary to address questions that include time and cycles. We as managers must recognize that long-term research is necessary and will pay off in large dividends in the long run. We must examine these issues critically and place our priorities into a holistic perspective.

We tend to concentrate the greater part of the area research within the core areas, and this is probably most appropriate, but we also should consider studies within the zone of cooperation. Examples of these kinds of projects might relate to air and water quality, wildlife, effects of agriculture and ranching practices, and the spread and control of exotic species. And these studies should include the social sciences as well as the biological sciences.

The 1963 National Academy of Science report to the Park Service included a paragraph that I would like to quote. The report stated:

> "National Parks are . . . more than areas of importance for the aesthetic, spiritual, inspirational and educational values inherent in their physiographic and biological features. They are irreplaceable natural laboratories in which scientific studies can be carried out which would not be possible in even the most elaborate and conventional man-made laboratory. In the national parks it is possible to study the structure, interrelations and behavior of biological communities, discover how they are adapted to their environment and compare them with the artificial communities elsewhere created by the clearings, drainages, and contamination, and by the introduction of exotic animals and plants by man. They offer the opportunity to pursue long-term ecological studies difficult, if not impossible, to conduct elsewhere."

In a sense, the natural areas of parks and forests that occur within biosphere reserves provide the control sites for the larger areas of influence. The core areas provide the only standard or common denominator by which management activities can scientifically be evaluated. They are the only known reference points from which we can draw indisputable conclusions about human and natural influences upon the

ecosystem. Although the emphasis usually is local or regional, global environmental concern should also be addressed whenever possible. Long-term monitoring within these core areas, designed as regional early-warning systems, is of utmost importance if we are to perpetuate that life-support system.

Monitoring is an extension of research because it involves the long-term data-gathering that is required for understanding of trends and the detection of perturbations that we might not detect otherwise. It includes the use of controls to detect changes in environmental conditions, or to discern whether a newly implemented program is working out as well as expected. Or it may be utilized as a means to adjust activities to a prescribed standard.

The question of research priorities is one all managers struggle with. Although these are often determined by issues that reach a critical stage, or are expected to become critical, there is one underlying theme that always is worthy of consideration, and is particularly important for biosphere reserves. That is the retention of or restoring of the area's genetic diversity.

Managers of natural systems need to manage for the perpetuation of the natural processes including the restoration of certain missing pieces of the matrix. This standard will, in the long-run, provide for greater resource protection by allowing for the natural properties to care for themselves. High species diversity generally signifies stable communities. The higher the diversity the longer the food chains, more cases of symbiosis and greater the possibilities for negative feedback, which reduce oscillations and hence increase stability (Margelef 1958).

The wild things of this earth represent a reservoir of genetic materials that we can ill afford to lose. We cannot predict or in any way foresee the ways that unidentified species may someday prove valuable. It is therefore vitally important that examples of our world be preserved intact with the minimum of human-induced influences for the time that man is wiser and possesses greater technology. Although we have great knowledge now, our ability to comprehend is multiplied every passing year.

The truth today, however, is that biosphere reserve managers are <u>now</u> in positions to provide the required environmental <u>protection</u> to valuable gene pools. We cannot wait for another chestnut blight before taking action; it is then too late. We have the opportunity <u>now</u> to protect and to restore. It should be our highest priority to reconstruct, whenever scientifically feasible to do so, the natural fabric within our areas of responsibility so that the natural processes that once provided their own stability and protection can again function properly. That task is our responsibility, and we should provide it our utmost attention and energy.

Let us recognize that our scientists are on our side in the battle of resource protection. They are not second-class citizens but an intricate part of the team. We must assure them the work space, equipment and personnel to do their part of the job.

Tools and Techniques

The caring for the biosphere reserve requires a personal commitment. It also requires the willingness to implement a systematic approach to resource management. Managing systematically involves the documentation of the issue, development of alternatives, the selection of the best method to address the issue, the assignment of the various tasks to the most appropriate individuals, and the monitoring of the results.

This process makes the scientists, resource specialists, interpreters and protectors all part of the same program. It makes the scientists responsible for an adequate database. It makes the resource specialists responsible for implementing specific action plans, protectors for the protection of the resources, and interpreters for the public support that is essential to the success of any one of the activities. It places management in the role of guidance and overview. It recognizes the importance of subjective judgment over total scientific management, but at the same time insists upon the use of good and adequate information.

The documentation of this process is the essence of the area's resource management plan, which is prepared by the area staff so that all pertinent individuals are permitted to contribute. All actions included should be allocated to specific individuals to assure compliance, and annual performance standards need to reflect those determinations.

National Park Service plan guidelines (NPS 1980) already are available, and every manager has responsibility for the area plan. This pivotal document requires annual review and updating, and is the heart of the systematic process of resource management. Without it, actions taken are more likely to be inconsistent, redundant, ill-conceived or mismanaged. Without a clear direction for each issue, seat-of-the-pants decisions dominate. One manager may choose inaction, another may take action too quickly without information and without documentation of what was done (Peter White, pers. comm.).

The body of the resource management plan is a series of project statements that address all of the area's resource issues. Some of these topics are more obvious than others. For example, the management of major wildlife such as deer, elk and bears, or backcountry and fire management, as well as endangered and the significant exotic species are most obvious. But some of the more subtle and often ignored issues may be important as well. Some examples include visitor use within the frontcountry, long-term monitoring, adjacent land-use practices, and reevaluation of landscapes for rezoning.

This latter issue is one that should receive greater attention early-on because it is critical within the context of the greater biosphere reserve. Wilderness, historic districts, various special protection zones, forests, ranch lands and agricultural lands must all be included. The already designated zones may need realignment. Although we must accept zones of heavy visitor use, we must also designate zones that cannot be visited at all except for scientific research. And we must get on with this evaluation even though we may at first be unsure of the results, because the process itself is sure to create a broader perspective out of which can evolve a more beneficial and holisitic commitment by everyone involved. As Aldo Leopold (1947) so nobly stated, "A land ethic changes the role of <u>Homo sapiens</u> from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow members, and also respect for the community as such."

One of the most critical issues that land managers face today is the lack of sufficient personnel and funds. Sheard and Blood (1973) suggested that agencies utilize the importance of biosphere reserves more often as the keynote for programs that provide protection to natural systems. Biosphere reserve managers have done just that, but I suspect that most of those justifications have little substance. We need to understand the concept and to prepare justifications around the functions and objectives, and perhaps more importantly, the regions and the central office must recognize the importance of biosphere reserves so that such a designation carries added clout.

Training of personnel and the education of non-personnel is also implicit within the concept of biosphere reserves. Although the Park Service already has a broad and successful employee training program, specific resource management training, directly oriented toward biosphere reserves, should be developed and made available. This effort should utilize the wide range of topics and papers previously prepared on the issue (Henning 1973; Curry-Lindahl 1974; Kilgore 1979; Wauer 1980). People who have knowledge share the responsibility to help resolve the problems and concerns of our environment.

There are a number of specific tools of which the biosphere reserve manager should be well acquainted. It is vitally important that he keep himself abreast of the most up-to-date methods and techniques, some of which have been made part of the poster session of this conference. Three in particular are worthy of your review, in my opinion. The visitor impact management evaluation concept, that has been developed by the National Parks and Conservation Association and University of Maryland (Graefe, Vaske, Kuss 1983), is an extremely valuable method to evaluate visitor uses within different zones to determine the necessities and priorities for mitigation. It is time to recognize that we can't continue to cater to unlimited numbers of people without destroying the very reasons these areas were so dedicated. In a theatre, when the seats are full and only standing room exists, the manager does not jeopardize the showing by allowing still more onlookers to impede the others. We are often so busy concerning ourselves about perceived political conflicts that we overlook the public's acceptance of certain restrictions. We can accomplish a good deal if we act with conviction, based upon an adequate database, and articulate our reasons.

The threats evaluation methodology, recently developed by Dr. Gary Machlis and his colleagues at the University of Idaho, provides a way to examine issues that might cause undue hardship on park resources. The system involves an on-site workshop with key staff members to ascertain threats and their potential impact upon park values. A "Critical Resources Problem Workshop" (Machlis and Wright 1983) was held at Glacier National Park in 1982 to examine issues at that biosphere reserve. Great Smoky Mountains National Park Biosphere Reserve will utilize the updated format this winter to reexamine its resource issues. I wholeheartedly recommend that all biosphere reserve managers consider its use.

Information management is an issue that has previously been mentioned, but it is another of those critical needs that cannot be over-emphasized. We not only must assure ourselves that all of the currently available information is accessible to management, interpretation and science, but that information on current and anticipated activities is also readily available. We can no longer afford the leisure, funds and personnel commitments for redundant or out-of-order projects, whether they be research, monitoring or management. The networking of our resource information tracking systems is essential. Several examples of how some parks and/or regions are addressing this issue are included within the conference poster session.

CONCLUSIONS

The biosphere reserve concept is an extension of an environmental ethic beyond the park or forest into the surrounding area of cooperation. The purpose is to instill in others an understanding of the principles of conservation for our mutual benefit. To assure success, it requires action that brings our neighbors into the planning and

decision-making processes relating to the greater biosphere reserve. It requires a commitment on our parts that may be different than we have previously experienced. It will require our utmost attention.

How we treat our environment will determine our future. It is within our power to take a course of action that will force us in the future to live at a mere subsistence level. It is also within our power to take the steps to help guarantee an improved quality of living and a wide range of human choice for the future. If we wait too long it may be impossible to keep available the opportunity of choice. Aldo Leopold (1947) wrote that "obligations have no meaning without conscious, and the problems we face are the extension of the social conscious from people to the land."

It is important to realize that we must use a good deal of prudence in establishing a working biosphere reserve with our neighbors. We cannot afford misunderstandings or mistrust to set back this and other programs. Although we know that our intentions do not include additional land controls or purchases, this perception is one that could occur, and we must take the greatest care that it does not.

Develop initial communications and trust around specific issues. Air quality monitoring, wildlife management, and control of exotic plant species could provide the most beneficial areas of mutual interest. Air, water, soil, minerals, vegetation and wildlife are the basis of our existence and the measure of our future. The conservation movement has progressed to the point that we now recognize the need for a longer involvement in protecting our resources to the degree that the whole region must be incorporated within a comprehensive program for our mutual benefit.

We are managers of the core and must see to it that that concept is made to work. It may be our last hope. And that hope is more than our dedication to the concept. It is our obligation to the future.

MANAGEMENT OBJECTIVES

1. To protect and perpetuate the significant and diverse natural resources and support systems therein, as free as possible from all adverse intrusions;

2. To establish and maintain a comprehensive research program that is responsible to the long-term perspective of ecosystem processes;

3. To establish and maintain long-term ecological monitoring within the principle habitats of the reserve that will provide for early-warning systems for the region;

4. To establish and maintain an interpretive program that is comprehensive in nature and includes both in-house and outreach capabilities, that is ecosystem oriented and involves man as an integral part of the biosphere;

5. To manage the unit within the greater purpose of the biosphere reserve that incorporates a greater zone of influence within the management perspective in such a way so as to form a cooperative association with all persons of mutual interest; and

6. To manage the unit within a systematic framework that incorporates all of the functions and related activities into a multidisciplinary program to benefit the natural and human ecosystems.

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WORKSHOPS ON MANAGEMENT ISSUES

On the second day of the conference, the attendees divided into five work groups to discuss the application of the biosphere reserve concept to specific management issues commonly found in North American biosphere reserves. The co-chairpersons of each workshop included a person with expert knowledge on the issue being discussed and a manager of a prominent biosphere reserve where the issue is important. The resource person first gave a background paper on the issue; then the manager summarized the circumstances of the issue at the biosphere reserve site. Each workshop was followed by a group discussion that explored how the MAB program could best be applied to the issue at hand. No standard method was applied to orchestrate group interaction.

THE SKY HAS NO LIMITS: AIR POLLUTION AND BIOSPHERE RESERVES

Molly N. Ross[1]

Abstract. Gaseous and particulate pollutants emitted from manmade stationary and mobile sources travel through the air to protected areas, including biosphere reserves. These pollutants can injure and destroy protected resources. For certain categories of areas, the law assigns responsibility and establishes mechanisms for the protection of the resources. The land manager can seize the opportunities thus created by knowing the current and projected status of vulnerable resources and harmful pollutants, determining the resultant effects on the resources and on the purposes and values of the area, identifying the sources of the harmful pollution, and taking all available actions to achieve mitigation or elimination of such pollution.

INTRODUCTION

That the sky in many senses has no limits, and the outdoor air no bounds, poses serious problems for those areas which civilization has marked for protection by painstakingly-determined boundary lines on the ground and on maps. The pervasive air is a resource in its own right and a critical factor in determining the quality of a biosphere reserve's, or park's, other resources. Just among the National Park System lands in the International Network of Biosphere Reserves, examples of resource degradation from air pollution include the following:

- In Sequoia and Kings Canyon National Parks, extensive visible ozone injury to ponderosa pine and sequoia seedlings; apparent significant, widespread degradation of scenic views from pollutant-caused visibility impairment;

- In Great Smoky Mountains National Park, visible ozone injury to white pine throughout the park; red spruce decline at higher elevations, probably related to ambient ozone concentrations, elevated concentrations of heavy metals in the vegetation and soil, and acidic deposition; visibility impairment;

- In Isle Royale National Park, undetermined effects from elevated concentrations of sulfur and heavy metals in park streams;

- In Everglades National Park, undetermined effects from elevated levels of sulfur in epiphytes at the eastern edge of the park, and elevated levels of arsenic and mercury in wildlife;

- In Big Thicket National Preserve, a decrease in the abundance of spanish moss, probably related to heavy metal pollution;

- In Big Bend National Park, significant visibility degradation, probably from manmade sulfates.

The responsibility to protect the resources of these and other protected areas from air pollution degradation is clear. For areas of the National Park System, the National Park Service Organic Act directs the National Park Service to administer its areas

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consistent with their "fundamental" conservation purpose. For areas which have been designated "Class I" air quality areas under the Clean Air Act, that Act charges the Federal Land Manager (FLM) with an "affirmative responsibility" to protect the "air quality related values" of the areas from "adverse impact." For areas which have been designated as biosphere reserves, the Man and the Biosphere Program creates a moral imperative to protect the areas as "secure" sites for research, resource management, education and training. The available tools to protect the resources of these and other protected areas, however, are not always commensurate with the protection responsibility, for various legal and technical reasons.

What can managers do to address the problem of air pollution in their protected areas? Among other things, managers can identify the resources and values to be protected, inquire into current and projected ambient pollution concentrations, discover the pollution concentrations which cause effects on sensitive resources, consider what types and amounts of effects would constitute an "adverse impact" on the area, determine the sources of pollution on the area, and take an active role in local, state, and federal air pollution issues and proceedings.

THE NATURE OF AIR POLLUTION AND ITS EFFECTS

The air is a natural resource in its own right. The air is also critical to the quality of other natural as well as manmade resources which parks, biosphere reserves, and other special areas are supposed to protect. Gaseous and particulate pollutants emitted from manmade stationary and mobile sources travel to protected areas through the air, variously over short or long distances and in original or transformed states. Depending on the chemistry of the particular pollutant, the meteorological, topographical, and other environmental conditions, and the specific natural or cultural resources, polluted air can harm protected resources in many ways. For example, air pollution can cause leaching of important nutrients from the soil, acidification and other forms of water quality degradation, and injury to the structure and/or function of vegetation; these effects can, in turn, lead to changes in ecosystem structure, diversity, and function. Air pollution can discolor and weather materials, such as historical buildings and monuments, as well as natural rock formations. Air pollution can degrade visibility, impairing one's ability to see and appreciate the form, contrast, detail and color of near and distant features. Finally, air pollution can diminish human and animal health and well-being.

<u>Gaseous pollutants</u>. The gaseous pollutants that most seriously jeopardize protected resources are sulfur dioxide, nitrogen oxides, ozone, carbon monoxide, hydrogen sulfide, and hydrogen fluoride.

<u>Sulfur dioxide</u> is a pungent, though colorless and odorless gas, that results from the combustion, smelting, or refining of sulfur-bearing fuels and ores. In the atmosphere, it can be transformed into an acidic fine particulate, i.e., sulfate, probably the principal component of both acidic deposition and visibility impairment. Sulfur dioxide pollution can aggravate respiratory diseases, damage the lungs, and irritate eyes. It can corrode building materials, paint, stone, metals, and electrical equipment. It can injure and destroy vegetation: sulfur dioxide has been found to cause lichen deserts; serious injury and growth reduction in Douglas fir, ponderosa pine, white pine, and forest shrubs; and damage to various crops, including alfalfa, grains, squash, cotton, grapes, and apples. Fossil fuel-fired power plants and industrial boilers, and copper and lead smelting and refining operations, are major sources of sulfur dioxide emissions.

<u>Nitrogen dioxide</u> is a pungent gas, yellowish or reddish brown in color, that results from combustion at high temperatures and pressures. In the atmosphere it can turn into nitrate, pollutants associated with acidic deposition and visibility impairment. In the presence of sunlight, nitrogen oxides can react with hydrocarbons to form photochemical oxidants, particularly ozone. Nitrogen dioxide can irritate the eyes, nose, and throat, and increase susceptibility to infection. It can suppress plant growth and cause chlorosis of leaves. It can create a brown cloud, seen frequently over certain urban areas, or a brown plume, associated with many coal-fired power plants. Although natural sources of nitrogen oxides, such as biological decay and forest fires, produce greater amounts of nitrogen oxides than manmade sources, it is the manmade sources that contribute to significant pollution problems in particular areas. Major sources of nitrogen oxides are coal-fired power plants, diesel and gasoline-fired motor vehicles, and industrial boilers.

<u>Ozone</u> is an unstable, colorless, slightly sweet-smelling gas. It is a "derivative" pollutant formed by the interaction of hydrocarbons and nitrogen oxides in the presence of sunlight. It is the most important of the "photochemical oxidant" pollutants which create smog. Ozone is the most toxic pollutant to vegetation commonly found. Its natural background levels are about 0.03–0.04 ppm, and injury to sensitive vegetation has been found at 0.05 and 0.06 ppm. Ozone can cause serious injury to eastern white pines, ponderosa pines, jeffrey pines, hardwoods, crops, and other vegetation; aggravate respiratory problems and impair breathing; irritate the eyes, nose, and throat; damage paint, discolor dyes, and accelerate the disintegration of rubber. Major manmade sources of ozone are the major sources of its precursor pollutants: for nitrogen oxides, the sources listed in the paragraph above, and for hydrocarbons, diesel and gasoline-fired motor vehicles as well as operations involving petroleum and petroleum products.

<u>Carbon monoxide</u> is a colorless, odorless, poisonous gas, created by incomplete combustion. Carbon monoxide is typically a localized pollution problem, magnified at higher altitudes. Carbon monoxide can cause dizziness, headaches, and slowing of mental processes; at higher concentrations, carbon monoxide can cause death. People afflicted with heart disease, anemia, asthma, and other respiratory ailments are particularly susceptible to carbon monoxide effects. Automobiles, trucks, and buses are the principal sources of carbon monoxide.

<u>Hydrogen sulfide</u> is a toxic, corrosive gas characterized by an unpleasant "rotten egg" odor which may not always be detected, however, at high concentrations. In addition to its odor, hydrogen sulfide can kill humans and animals; injure and destroy plants; and discolor and deteriorate paint and other building surfaces. Manmade sources of hydrogen sulfide include flaring and production of so-called "sour" natural gas; certain petroleum, chemical, geothermal, and metal refining processes; and kraft pulp and paper manufacturing.

<u>Hydrogen fluoride</u>, which occurs in both gaseous and particle form, is the most toxic pollutant to protected resources. Vegetation readily absorbs and accumulates it. Even at very low levels, hydrogen fluoride can injure vegetation, e.g., causing needle death in ponderosa and lodgepole pines, and leaf injury, leaf mortality, and growth reduction in firs, mosses, and ferns. Animals which eat vegetation with accumulated fluoride levels can develop serious defects in teeth and bones, disruption of enzyme functions, weight and appetite loss, lameness, reduction in fertility and milk production, and death. Sources of hydrogen fluoride include phosphate operations including fertilizer plants; aluminum refining; iron and steel production; and brick, tile, and glass products manufacturing.

Particulate pollutants. The term "particulate matter" encompasses a variety of pollutants, both liquid and solid, toxic and harmless, organic and inorganic, visible and microscopic, and the term "total suspended particulates" encompasses most of these pollutants. Large particles, such as fugitive dust from mining and agricultural operations, can cause soiling and nuisance. Relatively more serious for protected areas, however, are the fine particle pollutants and toxic particle pollutants, described below.

Fine particle pollutants, such as the sulfates formed from sulfur dioxide and the nitrates formed from nitrogen oxides, constitute one of the most difficult air pollution problems today. Their small size, 2.5 microns or less in diameter, facilitates their long distance transport, often hundreds of miles, before falling to earth. As effective light scatterers, they degrade visibility by reducing visual range and acuity. Particles up to 10 microns in diameter can cause respiratory disease, exacerbate respiratory and cardiovascular disease, impair health defense mechanisms, and result in morphological alterations, carcinogenesis, and death. Atmospheric fine particles ultimately may be deposited in dry form on soils or vegetation, or may be "precipitated out" as sulfuric or nitric acid. This acid deposition/precipitation can degrade water quality, leach toxic metals from the soil, and damage wildlife habitats and food sources, depending on the characteristics of the receptor; it can also bleach and accelerate weathering of natural rock formations and of manmade materials and structures.

Toxic particle pollutants include fluoride particles, discussed above; arsenic, a carcinogen emitted from copper, lead, and zinc smelters; beryllium, a carcinogen used in rocket fuels and metallic alloy production; asbestos fibers, an agent of lung disease, often produced by the deterioration of motor vehicle brake linings; and lead, a cause of kidney, brain, and central nervous system damage, primarily produced by combustion of leaded fuels in motor vehicles.

AUTHORITIES FOR RESOURCE PROTECTION

The challenge of developing adequate measures for protection of the resources, values, and purposes of biosphere reserves, units of the National Park System, and other special areas, is tremendous. The difficulties include, among others:

- The complexities, uncertainties, and variety of possible interpretations of the chemistry, biology, ecology, and other science, suggested by the above discussion of the air pollutants;

- The complexities, uncertainties, and variety of possible interpretations in the monitoring and modeling of air pollutant concentrations;

- The lack of consensus and precision as to what must be protected, to what extent, and at what cost.

Nevertheless, the Clean Air Act and various management statutes potentially provide the authority to protect the resources, values, and purposes of biosphere reserves, units of the National Park System, and other special areas. The effectiveness of these statutes seems to depend on the interpretations of those who administer the statutes, the activism of those who administer the areas and those who care about them, and the adequacy of information on the effects of air pollution.

The Clean Air Act. The Clean Air Act (CAA), as enacted in 1970 and amended in 1977, sets out to assure safe and acceptable ambient air quality throughout the nation. The nationwide goal of the CAA is the attainment and maintenance of "national ambient air

quality standards" (NAAQS): "primary" standards to protect the public health "with an adequate margin of safety," to be attained by dates certain, and "secondary" standards to protect the national welfare, to be attained "within a reasonable time." The CAA, in turn, defines "welfare" to include "effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility, and climate, . . . as well as effects on economic values and on personal comfort and well-being."

NAAQS are air pollutant concentration levels, set on the basis of a scientific "criteria document," without consideration of costs. NAAQS are required for pollutants reasonably anticipated to endanger public health or welfare that are emitted from numerous or diverse sources. The Environmental Protection Agency (EPA) has set NAAQS for six "criteria pollutants," i.e., sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. State and local governments may set additional, or more stringent, standards.

At any time, a particular area may be "cleaner" or "dirtier" than the NAAQS for a criteria pollutant. The CAA supplements its nationwide goal of attaining and maintaining NAAQS with specific goals for these "clean" and "dirty" areas. For the clean and unclassified areas of the country, the CAA seeks to "prevent the significant deterioration" (PSD) of the air quality, particularly in areas of special natural, recreational, scenic, or historic value. For the "dirty" or "nonattainment" areas of the country, the CAA demands that "reasonable further progress" be made toward the attainment and maintenance of NAAQS.

In pursuit of its NAAQS, PSD, and nonattainment goals, the CAA imposes various limits on emissions from individual pollution sources. These performance and emission standards include:

- New source performance standards (NSPS), emission control standards for categories of sources, such as new power plants and industrial processes;

- National emission standards for hazardous air pollutants (NESHAPS);

- Best available control technology (BACT), best available retrofit technology (BART), reasonably available control technology (RACT), and lowest achievable emission rate (LAER), all specific standards applied in different circumstances;

- Stack limitations, continuous emission controls, and other requirements to assure that the methods used to implement standards do not eliminate one pollution problem by creating another; and

- National motor vehicle emission control standards.

The CAA establishes the State Implementation Plan (SIP), or a substitute EPA plan, as the means to effectuate the NAAQS, PSD, and nonattainment goals and to apply the measures listed above. The SIP contains, at a minimum, all the federal air pollution requirements enforceable in the state. The CAA requires that federal, state, and local agencies, as well as the general public, be given adequate opportunity to comment on the development and revision of SIP's. After preparing its SIP, the state must submit it to EPA for approval. If approved, the SIP can be enforced by EPA and the federal courts; indeed, the CAA requires EPA to enforce the SIP if the state fails to enforce it adequately. If EPA disapproves the SIP, or if a state fails to submit a SIP, then EPA must promulgate a substitute federal implementation plan.

Part C of the CAA, entitled "Prevention of Significant Deterioration of Air Quality," deserves particular discussion as a prime authority for protecting the resources of parks, biosphere reserves, and the like from air pollution damage. No doubt because PSD "divvies up" the scarce clean air resource and protects special resources from external activities, extensive litigation has marked the creation of PSD as well as each stage of its development.

In certain respects, Part C is a resource protection statute. One of its purposes is "to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value." PSD addresses resource protection through the establishment of ceilings on additional amounts of air pollution over baseline levels in clean air areas, the protection of the air quality related values of certain special areas, and additional protection for the visibility value of certain special areas.

More specifically, Part C reflects Congress' judgment that, among the "clean air" regions of the country, certain areas--the "Class I" areas--deserve the highest level of air quality protection. Congress designated 158 areas as Class I areas, including national parks over 6,000 acres, national wilderness areas over 5,000 acres, national memorial parks over 5,000 acres, and international parks, in existence on August 7, 1977, the date of enactment of the Clean Air Act Amendments. At least sixteen of the United States biosphere reserves are, or include, Class I areas (Table 1). Congress further invited the states and Indian governing bodies to "redesignate" any other area Class I, as certain Indian governing bodies have since done. In this regard, Class I status would increase the opportunities for air quality protection in any biosphere reserve, and seems particularly desirable for "core" areas whose resources should be "preserved" and, as appropriate, "enhanced."

Table 1.--United States Biosphere Reserves Designated "Class I" for Air Quality Regulation.

Aleutian Islands National Wildlife Refuge (part)
Yellowstone National Park
Denali National Park and Biosphere Reserve (part)
Everglades National Park (including Fort Jefferson National Monument) (part)
Glacier National Park
Olympic National Park
Sequoia and Kings Canyon National Parks
Big Bend National Park
Great Smoky Mountains National Park
Rocky Mountain National Park
Three Sisters Wilderness
Virgin Islands National Park
Isle Royale National Park
Hawaiian Islands Biosphere Reserve (Haleakala National Park; Hawaii Volcanoes National Park)
South Atlantic Coastal Plain Biosphere Reserve (part)
California Coast Ranges Biosphere Reserve (part)

In these Class I areas, once "baseline" is triggered by submission of the first permit application from a major new source, Part C allows only the smallest "increment" of pollution to be added to the air. Thus far, the only "increments" to have been set are statutory increments for sulfur dioxide and particulate matter. EPA has not met the statutory schedule for setting increments, or creating equivalent measures, for hydrocarbons, carbon monoxide, photochemical oxidants, and nitrogen oxides.

Congress did not limit protection of Class I areas, however, to ceilings on additional pollution. Congress also established a site-specific resource test, known as the "adverse impact" test, to determine whether emissions from (at least) major new sources will cause an "adverse impact" on the "air quality related values" of the Class I area. Originally conceived by industry advocates as a variance from the small Class I increment, the adverse impact test was subsequently accepted by environmental advocates as a means to protect Class I areas regardless of increment compliance or violation. In the case of a major new source (or expansion), the adverse impact test works as follows:

- If the Federal Land Manager (FLM) determines, and convinces the permitting authority, that the new source will adversely impact the Class I area's resources---even though the new source's emissions will not contribute to an increment violation-- a permit shall not be issued;

- If the FLM certifies that the new source will not adversely impact the Class I area's resources---even though the new source's emissions will contribute to an increment violation---the permitting authority may issue a permit.

The adverse impact test institutionalizes the FLM in new source permit review at an early stage. It imposes an "affirmative responsiblity" on the FLM "to protect the air quality related values (including visibility)" of Class I areas, and, as the Senate committee wrote, "[i]n the case of doubt, . . . [to] err on the side of protecting the air quality related values for future generations." "Air quality related values" include all values in an area dependent upon and affected by air quality, such as scenic, cultural, biological, and recreational resources, as well as visibility itself. The current working definition of "adverse impact" is any impact that:

- Diminishes the area's national significance, and/or

- Impairs the structure and functioning of ecosystems, and/or

- Impairs the quality of the visitor experience.

In addition to increment ceilings and the adverse impact test, Congress enacted one more resource protection measure for Class I areas, namely, "visibility protection" for the 156 (of 158) statutory Class I areas where visibility is an "important value." In Part C of the CAA, "Congress . . . declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I federal areas which impairment results from manmade air pollution." In this provision, Congress expressed the national desire to preserve, for its own sake, the ability to see long distances, entire panoramas, and specific features, both in and, as EPA has interpreted the provision, from the statutory Class I areas. EPA is still developing the regulatory program to assure "reasonable progress" toward the national visibility goal, through new source review requirements, a visibility monitoring program, imposition of "best available retrofit technology" on major existing sources that impair visibility in statutory Class I areas, development of "long-term (10-15 year) strategies," and

consideration of "integral vistas" viewed from within the protected areas. To date, EPA's rulemaking proposals have addressed only "plume blight" and other visibility impairment "reasonably attributable" to a specific source or sources. EPA has not yet proposed regulations to address visibility impairment from "regional haze."

As the above discussion demonstrates, the CAA creates several opportunities and tools for protecting the resources and values of Class I areas. New pollution after baseline in Class I areas is generally limited to the small Class I increment, the FLM must determine whether major new sources will adversely impact the areas, and measures must be developed to protect the visibility of Class I areas from manmade pollution impairment. The states must develop their PSD plans with FLM consultation and a public hearing. Major new sources must undergo an equally public permit review, involving air quality monitoring; analysis of resource impacts; application of "best available control technology;" and effective emission ceilings based on the Class I increment, NAAQS, adverse impact threshold, or possibly visibility impairment threshold, whichever is the lowest. Existing sources may be regulated to protect visibility or to remedy a violation of an increment, NAAQS, or arguably Class I resource protection.

As demonstrated by its previously quoted purpose, Part C's concern for resource protection is not limited to Class I areas. Congress designated all other "clean air" regions of the country "Class II. Congress further prohibited redesignation not only of statutory Class I areas to any other classification, but also of certain Class II areas to the "dirtier" Class III classification. These so-called Class II "floor" areas include the following areas when greater than ten thousand acres: national monuments, national primitive areas, national preserves, national recreation areas, national wild and scenic rivers, national wildlife refuges, national lakeshores and seashores; as well as national parks and wilderness areas established since August 7, 1977. Class II increment ceilings on additional pollution over baseline concentrations allow for moderate development in Class II areas. Class II increments constitute an absolute ceiling on additional pollution in these areas, because Congress did not qualify the Class II increment with an adverse impact test.

Although the CAA does not create as many resource protection tools for Class II areas as for Class I areas, it nevertheless creates opportunities. The FLM, or manager of a biosphere reserve, can participate in State Implementation Plan proceedings, new source reviews, and other federal, state, and local activities that potentially affect the air quality of their areas. As appropriate, the land manager can undertake or encourage efforts to redesignate the area to Class I. In the case of units of the National Park System and perhaps other land management systems, managers also may have residual authority, probably statutory and possibly common law, to protect their areas from adverse air pollution impacts in most cases.

At this time, there are no "Class III" areas. States or Indian governing bodies have the authority to redesignate to Class III any "clean air" area except a statutory Class I or Class II "floor" area. Class III designation could allow for substantial air pollution increases over baseline in the area. The redesignation process itself, as well as subsequent new source reviews, provide opportunities for land managers to have their air quality concerns considered.

For biosphere reserves, parks, or other protected areas that are in, or affected by, the "dirty regions" of the country where the National Ambient Air Quality Standards have not yet been met, Part C's Prevention of Significant Deterioration provisions do not apply. Instead, Part D of the Clean Air Act sets forth the requirements for these

"nonattainment" areas. As with Class II and III areas, the CAA does not establish an explicit role (other than consultation) for the FLM, but it does require public proceedings at various times. For example, the state must hold a public hearing prior to promulgating a "nonattainment SIP." The nonattainment SIP is a plan for attaining all national ambient air quality standards "as expeditiously as practicable," most primary NAAQS by 1982, and primary NAAQS for ozone and carbon monoxide by 1987. The nonattainment SIP must demonstrate "reasonable further progress" toward NAAQS in the interim; provide for reasonable available control technology on sources in the area; analyze effects on air quality, welfare, health, society, and economics; and must also hold a public hearing prior to issuing a permit for a new source. To obtain a permit, new sources in urban areas must secure from other facilities "emission offsets" greater than the new source's proposed emissions; in addition, a new source's control technology must comply with the "lowest achievable emission emission rate" for such a source.

As a final word about the Clean Air Act, the above discussion has reviewed many provisions that, directly or indirectly, can address many air quality concerns in protected areas. Unfortunately, the Act---at least as currently interpreted or implemented---does not address all such resource protection concerns. For example, the Act often does not deal effectively with the following concerns:

- The individual and cumulative air quality impacts of sources not subject to PSD permit requirements, such as "minor" sources, sources located in nonattainment areas, existing sources, and sources located in foreign countries;
- Regional loadings of air pollutants; and
- Long-range transport of air pollutants.

Despite these deficiencies, informed managers of special and protected areas can press the current system to its limits in defense of the resources. Managers of biosphere reserves that are layered with other land management designations, e.g., national park, national wilderness area, national forest, etc. can couple CAA tools with their other authorities. For example, units of the National Park System must be administered "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 U.S.C. 1). Moreover,

> [t]he authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress (Id. 1a-1).

Essential to making the existing statutory authority work for the protection of the resources, however, is the gathering and development of the relevant scientific and technical information on which the legal system depends.

STEPS FOR AIR QUALITY MANAGEMENT

Protection of air quality related values depends on the far-sighted development of relevant information and knowledge. The manager of the biosphere reserve can gather much information at his or her level; store, disseminate, and use it, as appropriate; and connect with other managers and air quality specialists, as necessary, for support and approaches beyond the local level. In these efforts, the land manager is pursuing the purposes of the biosphere reserve, i.e., research, monitoring, education, and resource management, toward the end of enabling human beings to live harmoniously and productively with the environment.

The land manager can begin by asking six basic questions about the protected resources, as follows:

1. <u>Which resources, if any, are known to be, or potentially may be, affected by an ambient pollutant? What are the effects?</u>

The manager can undertake an inventory of the area's air quality related values, all those resources, values, and purposes of an area dependent in some way on the air quality. Since the effects of air pollution have not yet been determined for all air quality related values, the manager can next identify certain known "indicator" resources, such as pollution-sensitive species, visibility in relatively pristine areas, and acidity of water resources and/or changes in sensitive aquatic organisms.

As for effects, the manager can learn the nature, extent, intensity, duration, frequency, and timing of potential or actual effects of particular pollutants. The manager can characterize the receptor resource, e.g., an endangered or threatened species, a dominant species, an area namesake species, a species important to visitor enjoyment. The manager can determine the susceptibility of the species to effects, e.g., heightened susceptibility from existing disease condition. The manager can ascertain the potential for synergistic effects, e.g., disproportionate effect from interaction of ozone and sulfur dioxide.

2. <u>What are the current and/or projected levels of the pollutant in the ambient air?</u>

The manager can estimate these levels through monitoring and modeling. Monitoring is essential to protection of resources, for both scientific and legal purposes. For example, if the air quality is relatively pristine, monitoring detects deterioration; if the air quality is already relatively deteriorated, monitoring identifies dangerous concentration levels. Managers can monitor, while researchers develop other necessary knowledge. With respect to modeling, mathematical models can predict or estimate a source's, or region's, contribution to pollutant levels at a receptor. Improvements in the accuracy of models will enhance new source review, as well as solutions to regional and long distance transport of pollutants such as ozone, regional haze, and acid precipitation. By using monitoring and/or modeling, the manager can learn the background levels of pollutants, their peak concentrations, the "baseline" level for PSD purposes, and the frequency, distribution, and duration of given pollutant levels.

3. Are the measured or projected pollutant levels high enough to cause effects?

The manager can work with an air quality specialist to determine the effects on the area's air quality related values at given pollutant levels. The answer develops from field surveys, literature searches, and research, such as sensitivity determinations and biomonitoring plots. The manager can support or encourage research by the staff, technical offices of the organization such as the National Park Service Air Quality office, universities, or other interested organizations.

4. How will the pollutant affect visitor enjoyment, significant protected resources, and the ecosystem?

As suggested previously, this question forms the basis of the "adverse impact" test. A judgment call, this test has been applied by the National Park Service in reviewing the impact of major new sources proposing to locate near Class I areas. In evaluating effects on "visitor enjoyment," the test may require identification of the visitor of concern, i.e., the passing-through visitor, the backpacker, the researcher, etc. In evaluating effects on "significant protected resources," the test requires a determination of the purposes, values, and resources for which the area has been established and managed. The manager bases this determination on a review of the enabling legislation or order, the legislative history, management documents, and the like. Finally, in evaluating "ecosystem" effects, the manager can guard against effects on dominant organisms within the ecosystem, on organisms that bring about important processes, and on environmental factors. Thus, effects on dominant species, effects on species that regulate nutrient pools, and effects on species that moderate extremes in the environment can all impair the integrity of the ecosystem of which they are a part. Although native rare species do not, by definition, have a major influence on the structure and functioning of the ecosystem, they are special resources, important for their contribution to overall biological diversity, and they probably make unknown contributions to the ecosystem of which they are a part.

5. What is/are the source(s) of the pollutant?

Different factors may govern the manager's decision to address a pollution problem depending on the source of the pollution. Pollution may come from natural sources, such as forest fires, volcanoes, geysers, and decomposing vegetation. Pollution may come from mobile sources, governed by special statutory and regulatory provisions. Pollution may also come from stationary sources, i.e., a pollution source which is in a fixed location. Stationary sources may be further characterized as "point" sources, "fugitive emission" sources, and "area" sources.

6. What can be done to control/mitigate the pollutant's emissions and effects?

This question has many answers, short-term and long-term; scientific, legal, and moral; executive, judicial, and legislative; confrontational and cooperative; appropriate variously at the area, local, state, federal, or international levels. The following suggest some of the answers:

- Planning processes. Incorporate air resource management goals, issues, projects, concerns, and protections in internal organizational planning, and provide similar input to other agencies and government bodies.

- Research and monitoring. Examples of air quality research include research on biological effects, visibility, visual values, and predictive modeling. Examples of

monitoring include monitoring of visibility, criteria pollutants, and air quality related values.

- Development and analysis of regulations and legislation. At all levels, managers can pursue appropriate activities to improve the implementation of already existing statutes intended to protect air quality related values, and to develop new authorities toward this end. Examples of this kind of activity include working with EPA to set National Ambient Air Quality Standards properly protective of health and welfare, working with the state and local governments to set additional protective standards, and the like.

- Environmental assessment documents. Managers can become involved at an early stage in environmental assessments and environmental impact statements for activities that could affect air quality. Managers can encourage the lead agencies to consider all potential impacts, including cumulative impacts, secondary growth impacts, and the like.

- Interpretive activities. Interpretation is an educational process which helps establish an awareness of the area's air resource for the enjoyment, appreciation, and edification of the public. Raising public consciousness of the air pollution problem in protected areas can be the key to action to address the problem.

- Clean Air Act activities. As discussed earlier, the Clean Air Act offers many opportunities for resource protection.

CONCLUSION

Air pollutants can injure and destroy the very resources and values for which biosphere reserves, parks, and other special areas have been established and managed. The Clean Air Act and various management statutes offer many opportunities to try to protect these resources and values. The manager has an awesome responsibility to protect the resources and to take full advantage of the available opportunities.

GLOSSSARY

<u>Air Quality Related Values (AQRV)</u> - Values possessed by an area that may be affected by changes in air quality, e.g., visibility, flora, fauna, archeological sites, historical structures, soils, water resources, visitor enjoyment, etc.

<u>Adverse Impact Test (or Air Quality Related Value Test)</u> – The determinative test under the Clean Air Act for deciding whether a new major source with the potential to affect a Class I area may obtain a PSD permit to construct. 42 U.S.C. 7475(d). If the Federal Land Manager determines, and convinces the State, that the new source will adversely impact the Class I area's resources or values—even though the new source's emissions will not contribute to an increment violation—a permit shall not be issued. Conversely, if the Federal Land Manager certifies that the new source will not adversely impact the Class I area's resources or values—even though the new source's emissions will contribute to an increment violation— the permitting authority may issue a permit.

<u>Baseline</u> – A term of art under the Clean Air Act, "baseline" refers to the date of submission of the first complete application for a PSD "permit to construct." The "baseline concentration" means the ambient concentration level of the pollutant in question which exists in the baseline area on this baseline date. 42 U.S.C. 7479(4).

<u>Class I Area</u> - Among the "clean air" areas of the country, where the air quality is better than the National Ambient Air Quality Standards, Class I areas are those lands given the highest degree of protection from future degradation of air quality. The Clean Air Act designates as mandatory Class I areas, <u>inter</u> <u>alia</u>, national parks over 6,000 acres and national wilderness areas over 5,000 acres in existence on August 7, 1977. 42 U.S.C. 7472(a).

<u>Class II Area</u> – Among the "clean air" areas of the country, where the air quality is better than the National Ambient Air Quality Standards, Class II areas are those lands given a moderate degree of protection from future degradation of air quality. The Clean Air Act designates as Class II all "clean air" areas of the country except those areas designated mandatory Class I. 42 U.S.C. 7472(b); see also, <u>Id</u>. 7474(a). States, or Indian governing bodies as appropriate, may redesignate Class II areas to the more protective Class I status or, in some circumstances, to the less protective Class III status. <u>Id</u>. 7474.

<u>Class III Area</u> – Among the "clean air" areas of the country, where the air quality is better than the National Ambient Air Quality Standards, Class III areas are those lands redesignated by a State or Indian governing body for the least degree of protection from future degradation of air quality. 42 U.S.C. 7474(a). Significant increases in pollution may be permitted in a Class III area as long as such pollution will not cause an exceedance of the National Ambient Air Quality Standard. <u>Id</u>. 7473(b)(3).

<u>Clean Air Act (CAA)</u> – 42 U.S.C. 7401–7642. Based on the Clean Air Act of 1963, the present CAA is primarily comprised of amendments enacted in 1970, Pub. L. No. 91–604, 84 Stat. 1676, and amendments enacted in 1977, Pub. L. No. 95–95, 91 Stat. 685.

<u>Criteria Pollutant</u> — A pollutant for which the Environmental Protection Agency has established a National Ambient Air Quality Standard. To date, the criteria pollutants are particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, lead, and ozone.

Federal Land Manager (FLM) -- Under the Clean Air Act, the FLM is "the Secretary of the department with authority over . . . [the] lands" in question. 42 U.S.C. 7602(i). For units of the National Park System, the Secretary has delegated his authority to the Assistant Secretary for Fish and Wildlife and Parks. Various officers of the National Park Service exercise this authority in routine matters, but the Assistant Secretary retains this authority in controversial matters.

Increments - The amounts of additional pollution, beyond already existing baseline levels, which may be allowed in a particular "clean air" (PSD) area. The size of the allowable increment varies with whether the area is designated Class I, Class II, or Class III. 42 U.S.C. 7473.

National Ambient Air Quality Standards (NAAQS) - National standards, established by EPA, which prescribe concentration levels of pollution in the outdoor air which may not be exceeded. 42 U.S.C. 7408, 7409. "Primary" NAAQS are set at a level to protect the public health, allowing an adequate margin of safety. Id. 7409. "Secondary" NAAQS are set at a level to protect the public "welfare" from any known or anticipated adverse effects. Id. The public "welfare" includes "effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being." Id. 7602(h).

Nonattainment Area - Nonattainment areas are the "dirty air" areas of the country, where the air quality is worse than the National Ambient Air Quality Standards. Part D of the Clean Air Act contains the requirements applicable to these areas for improving the air quality in order to meet the National Ambient Air Quality Standards. 42 U.S.C. 7571-7578.

Prevention of Significant Deterioration (PSD) - 42 U.S.C. 7470-7491. The PSD requirements, contained in Part C of the Clean Air Act, constitute a planning and management process for allocation and use of the air resource in the "clean" areas of the country, where pollution concentrations are below the National Ambient Air Quality Standards.

State Implementation Plan (SIP) - A state developed, federally approved plan for implementing and enforcing the requirements of the Clean Air Act. 42 U.S.C. 7410. With certain exceptions, a state with an approved SIP is responsible for allocating the air resource within its boundaries.

AIR POLLUTION AND SEQUOIA AND KINGS CANYON NATIONAL PARKS

Boyd Evison[1]

Abstract. Air pollution reaches Sequoia and Kings Canyon National Parks in large quantities, with effects that are not yet well understood. A research program has begun, to 1) establish baseline information on ecosystem structure and processes, 2) monitor incoming pollutants, and 3) monitor changes over time. Visibility monitoring also has begun. A highly coordinated effort is underway through which most research is being done by scientists supported by funds from outside the National Park Service's budget. Gaps remain in the program; but the information being gathered will be of incalculable value to management.

INTRODUCTION

Sequoia and Kings Canyon National Parks, the largest and most-nearly pristine area now preserved in the Cascade-Sierra Biogeographical Province, is assaulted daily by the spillover of air pollution from the San Joaquin Valley--which is an agricultural area of extraordinary economic and social significance.

The National Park Service recognizes its responsibility to gauge the effects of air pollution on the Parks' resources, and if appropriate, to mitigate them; but we are profoundly hampered in doing so, by the lack of baseline information, and by our inability to fund adequately the collection of such information and data on the kinds, amounts, and sources of pollutants, and the ecosystem changes that they may cause.

The Parks' staff has therefore concentrated on designing a research program that will guide collection of the necessary information; providing the best research facilities, support staff, and ambience that it is able to; and using those qualities, along with the Parks' enormous natural appeal, to attract the conduct of needed research by scientists who are able to obtain funding from various sources in the public and private sectors.

These efforts have resulted in a program funded at a level that is equal to about 15 percent of the Parks' operating budget; but significant gaps remain, and additional funding still is badly needed. Park management is continuing its efforts to gain understanding of, and support for, the program.

THE RESOURCES

Sequoia and Kings Canyon National Parks, managed as a single unit, comprise 344,000 hectares of the southern Sierra Nevada of California. The Parks are buffered on the north, east, south and northwest by National Forest land, much of which is designated wilderness. The parks span an elevation gradient from 400 to 4,418 meters, and include excellent examples of many of California's most representative ecosystems. These include foothill grassland, chaparral, mixed conifer and subalpine forests, meadows,

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and riparian, alpine and aquatic communities. Many hundreds of lakes grace the rugged high country, and the streams that lace it unite to form three of the State's major rivers.

The great majority of the Parks' area is perhaps as well protected from contemporary human impacts as is any place of comparable area in the 48 contiguous States. They can serve well as reference points against which to measure the effects of human activity on similar areas on which comparable data are now beginning to be developed. Although zones of cooperation have not officially been designated, an array of sites now being studied in other places in and near the Sierra Nevada and the Cascades serve informally in that role. In addition, resources in limited areas within the Parks are manipulated to mitigate the effects of various human activities, and offer excellent opportunity for study of the effects of such manipulation and of the activities themselves. The latter include those associated with roads, trails, campgrounds, concession-operated accommodations, and administrative facilities, which occupy less than two percent of the Parks' land area.

The Parks are, by National Park Service standards, unusually well endowed with research staff and facilities. Two permanent research scientists, a permanent ecologist, and several seasonal technicians are supported by a recently established (1982) research center in the Parks, consisting of a field laboratory, offices, and dormitory space. The technicians assist project investigators with routine sampling and data collection, substantially reducing logistical problems and support costs. Significant direct support also is provided by a professional Resource Management Division, which carries out much of the monitoring associated with air pollutants and impacts. In addition, the Cooperative National Park Resources Studies Unit (CPSU) at the University of California's Davis campus provides academic support facilities, and functions as an administrative clearinghouse for cooperating University scientists. The Parks' strong support of basic and applied research has helped attract scientists from across the nation, most of whom work with funds from sources outside the National Park Service.

THE ISSUE: AIR POLLUTANTS

Sequoia and Kings Canyon National Parks are at the eastern edge of the San Joaquin Valley, the monetary value of whose agricultural production exceeds that of any but three nations. The Valley is a 400 kilometer trough running north to the Sacramento Delta, which in turn drains into San Francisco Bay. At one time, rivers and lakes augmented by unusally heavy rains made it possible for steamboats to travel from San Francisco the length of the Valley, to Bakersfield, south of Sequoia-Kings. However, agricultural manipulation has transformed formerly submerged lands, and the water that once submerged them, into food and fiber "factories."

Now it is a panoply of airborne pollutants, rather than steamboats, that make their way down the Valley. Prevailing northerly winds deliver a load of factory and vehicular emissions from as far as Richmond, in the San Francisco Bay Area, augmented by what is emitted along highways I-5 and U.S. 99, and the network of roads and industrial sites serving Stockton, Modesto, Merced, Madera, Fresno, Visalia, and Bakersfield. Spray planes, spreaders, and irrigation systems inject assorted agricultural chemicals into the system, and cultivation and burning add a substantial increment of particles and gases to the mix.

Much of the year Visalia--about 40 miles from the towering Sierra Nevada--might as well be in Kansas; the range is obscured by smog. Views from the Parks into and across the Valley to the Coast Ranges, reportedly seen in the past with great regularity, now most often fade quickly into a brownish-gray pall, after a day or so of clarity following passage of a storm front. Visible pollutants are pressed against the mountains, building often to depths of a thousand meters, and sometimes deeper, spreading over 4,000-meter passes to the east side of the Sierra. There, beyond the Parks, they are likely to meet pollutants blown up the Owens Valley from Los Angeles.

The ozone, acid precipitates (wet and dry), and other particles and gases arriving in the Parks certainly bring changes in their ecosystems. It seems that no place on earth is exempt from some alteration by modern anthropogens; but this is clearly a serious concern, in terms of the Service's mandate to protect natural ecosystems' integrity--a mandate implicit in the legislation that established the Parks, reinforced by their status as an International Biosphere Reserve, and compelled by the Clean Air Act, by which the Parks are to be protected from degradation of air quality.

The appropriate response to such a threat seems obvious: measure the input of pollutants into the Parks and identify their sources; measure the changes associated with the pollutants; and take whatever steps are possible to mitigate them or model, as best we can, what our system would be like without those pollutants. Unfortunately, the foundation on which such understanding must be built is now very shaky. We lack basic descriptive information on ecosystems structure and processes in most of the Parks' natural communities, so it is not possible to judge accurately the effects of the influx of air pollutants (or of any other anthropogens, now or in the future). It is thus necessary to operate now on two fronts, building the foundation of ecosystems data while beginning long-term monitoring of inputs; and then to follow on with measurement of any changes in ecosystems structure and process as they may relate to those inputs.

The acquisition of such data requires a much larger investment in research and monitoring than the National Park Service is now prepared to finance. It therefore has been necessary to concentrate much effort on building a cooperative relationship with scientists funded by other federal, state, and private sources. Most of the projects falling under the auspices of the research program developed by the Parks' scientists and managers will be carried out either under contract or cooperative agreement. The Parks' two research scientists are responsible for primary guidance in selection of subjects, and for coordination of the overall program. This includes assuring that sample collection and analysis are carried out on schedule and according to established protocols; facilitating interaction, data exchange and integration between projects; and assuring application of results to program objectives.

THE RESEARCH AND MONITORING PROGRAM

Objectives and Scope

The primary objectives of the Parks' air pollution research program are to 1) establish baseline values, 2) monitor trends of anthropogenic pollutants, and 3) determine and continue to monitor potentially sensitive ecosystem parameters across the broad elevation gradient offered by the Parks. In addition to information on basic ecosystem

structure and process, and inputs of acid precipitation and oxidant air pollution, this will require measuring the effects of fire, a natural process element now cautiously being reintroduced after many years of vigorous protection.

In pursuing support for these studies, first priority has been given to the quantitative measurement of atmospheric concentration and deposition of pollutants, and detection of symptoms of ozone damage, and estimation of hydrological and chemical balances for selected watersheds. Second priority has been given to the collection of data necessary to understand the more complex effects of atmospheric pollutants on the terrestrial and aquatic ecosystems of the area. To date, we have been remarkably successful in attracting substantial support for projects in both priorities. The Parks are performing their biosphere reserve role well by serving as a site for a major part of the State of California's acid precipitation/ecosystems research. The California Air Resources Board has assigned a full-time professional to on-site coordination of the work it funds. This project has become an exceptionally positive example of Federal/State cooperation. The data gathered by this and an array of other cooperative efforts will be of incalculable value for comparing results with those from more heavily affected areas, as well as providing a baseline for measuring the magnitude and direction of future changes within the Parks.

Preliminary Hypotheses

While the research program is designed primarily to provide baseline trend monitoring of atmospheric inputs and ecosystem processes for a remote natural area, it has been helpful to develop a number of site-specific hypotheses, or general questions to be addressed. These include the following:

1) Relative susceptibility of different Sierra ecosystems to acid precipitation is a function of local geology, soil development and chemistry, biota, weather patterns, and climate.

2) Atmospheric inputs vary as a function of elevation in the Sierra Nevada.

3) In the Sierra Nevada, dry deposition is as significant a source of pollutants as is rain or snow.

4) Weakly buffered Sierran lakes are highly susceptible to increased acid precipitation.

5) A strong pulse of acidic snowmelt in the spring may place high Sierra lakes under severe biological stress.

6) Acidic inputs may be reflected in changes in soil chemistry (especially N cycling), microbiology, and litter decomposition rates.

7) Acid precipitation may affect plant productivity, phenology, and community composition.

8) Natural fire regimes and the biogeochemical effects they induce mask the effects of low level acidic inputs on Sierra ecosystems.

9) The effects of ozone may now be more severe than those of acid precipitation; and the two will be difficult to sort out.

To a varying degree, these hypotheses have been addressed in the development of the study design for the research program.

STUDY DESIGN

Acid Precipitation

While acidic precipitation has been documented as occurring in the Parks, no impacts directly attributable to it are known. The Park scientific staff is cooperating with the California Air Resources Board, the U.S. Geological Survey, University of California scientists, and others to document baseline ecosystem parameters of the type known to be sensitive to acid precipitation. This project is a long-term ecosystem study designed to provide baseline data on such topics as aquatic chemistry and biology, soil mapping and chemistry, snow melt processes and plant succession and productivity, which are among the parameters most sensitive to acid precipitation.

To reduce logistical problems and variability in results, research is concentrated along an elevation gradient in the Middle and Marble Forks of the Kaweah River drainage. In general, the strategy is to emphasize baseline/cataloging types of information in the early years of the study. It is anticipated that following several years of intensive baseline data collection, many measurements will be needed only on an intermittent basis.

Three primary study sites have been selected for intensive study. Spanning much of the Parks' elevation gradient, the sites include low elevation chaparral, middle elevation mixed conifer forest and high elevation subalpine communities. Each site is located away from developed areas and possible sources of local contamination. Each site consists of a headwater drainage basin bordered by relatively distinct topographic divides. In each basin, detailed terrestrial, aquatic, and continuous meteorological measurements are integrated and directed towards understanding biogeochemical and hydrological cycles (including input and output measurements), as well as basic structural and functional characteristics of the aquatic and terrestrial systems. Quantification of the amount and chemistry of input from rain, snow, dry deposition and nitrogen fixation is focused in or near these areas. Emphasis is placed on integrating input/output budgets with associated process-level studies, in order to quantify internal sources and sinks of acid and other pollutants. Because of the importance of fire in biogeochemical cycling and pH fluctuations, replicate study areas will be experimentally burned in conjunction with the low and middle elevation study areas, and pre- and post-burn sampling conducted.

The primary study sites were selected as representative ecosystems on the basis of available information on the soils and vegetation of the Park. The primary study sites are as follows:

1. Elk Creek, 750 m elevation. A dry wash granitic drainage in which water flows only during moderately heavy storm events. The drainage to be studied is about 5 hectares in size and is dominated by evergreen chaparral shrubs.

2. Log Meadow, 2,070 m elevation. A perennial stream drainage about 38 hectares in size. The Log Meadow site is typical giant sequoia mixed conifer forest. Other common tree species include white fir, red fir, and sugar pine.

3. Emerald Lake, 2,800 m elevation. This granitic drainage, about 125 hectares in size, is a typical high subalpine basin. Emerald Lake itself is 2.6 hectares in size and is fed primarily by snow melt from the surrounding basin. A single, well defined channel drains the lake. Vegetation is sparse with much of the basin being exposed rock. Scattered clumps of lodgepole pine, western white pine, and foxtail pine also occur in the drainage. Several shrubs are locally common.

Ozone

Although the primary study sites were established with acid precipitation in mind, ozone studies are being related to them. The effects of ozone are thought to be most significant in the middle elevation areas of the Parks. Ozone monitors are operated cooperatively with the EPA and the California Air Resources Board (CARB) at four places in the Parks. Field plots have been established to monitor ozone symptoms. Damage ranging from undetectable in remote areas to severe on trees in drainages exposed to Valley pollution has been found. These plots, some of which were established jointly with U.S. Forest Service personnel, will continue to be monitored.

The severity of ozone damage on yellow pine in some areas prompted additional studies of the effects of ozone on key plant species. Research is underway to detect possible ozone damage to mature black oak and to sequoia seedlings (both in fumigation chambers and in the field). Preliminary findings indicate substantial damage to black oaks. Findings regarding impacts on sequoia seedlings are as yet inconclusive, but suggest strongly the possibility that damage is occurring.

Visibility

Visibility monitoring was started in 1983. Automatic cameras at Moro Rock and Lower Kaweah (Giant Forest) record visibility down the Kaweah Canyon three times a day. One camera was placed on the Sierra Crest looking toward the Owens Valley during the summer of 1983. While the photos have yet to be quantitatively evaluated, it is readily apparent that visibility is severely impaired by pollutants at many locations. Visibility impairment is primarily a function of increased concentrations of fine particulates and photochemical aerosols during long dry periods.

STATE OF THE PROJECT

The catalyst for the greatly increased attention being given research into the effects of air pollution on the Parks was their selection, in 1981, as one of the initial three units of the National Park System to be studied under the auspices of the National Acid Precipitation Assessment Program (NAPAP). From the outset, emphasis was on the collection of baseline data necessary to detect subtle, but potentially very significant, changes in soil, vegetation and aquatic environments. NAPAP funding was directed to the integrated watershed study. This part of the overall project will provide the beginning of a Park-wide Geo-based Resources Information System (GBIS). This framework for the collection, storage, retrieval and analysis of data on biotic and abiotic resources will provide information that can be crucial in making park management decisions.

Cooperative efforts supporting aspects of the Parks' acid precipitation/ecosystem study as of October 1984 include the following:

National Park Service Interagency Acid Precipitation Funds - These funds, which are to continue through 1991, have been used primarily to establish and describe the three primary study sites, to monitor precipitation and stream chemistry, gauge stream flow at Log and Elk Creeks, establish and maintain meteorological stations at each site, establish a vegetation monitoring program, establish a water chemistry laboratory, and provide logistical assistance to contract and cooperative studies. Contract studies also

supported with these funds include soil survey and mapping of all sites, soil chemistry of selected soil types at all sites, preliminary studies on aquatic chemistry and biology at all sites, and establishment of a phenology, water relations and productivity monitoring program for key plant species at all sites.

Other National Park Service (NPS) Programs – The NPS Denver air quality office is funding projects on ozone effects on important tree species (includes field observations, fumigation and tree ring studies) and on lichens that might be susceptible to air pollution damage in the lower elevations of the Park.

Additional studies that are providing information of value to the Park program have been funded by the NPS Denver Service Center and the National Park Service Interdisciplinary Science Team Program, including a geologic survey of Giant Forest/Lodgepole area; an overview of surficial geology and geomorphology of the Crescent Creek basin (preliminary survey); an overview of geology of Emerald Lake basin in relation to acid precipitation (preliminary study); seismic refraction studies of the thickness of alluvium in the Wolverton ground-water basin and beneath Crescent Meadow; and stream-forest ecosystem interactions in the mixed conifer forest zone.

US Geological Survey – The USGS has made a long-term commitment to monitor stream hydrology and water chemistry (including aluminum and other metals) at Emerald Lake. The survey is supporting investigations into stream hydrology (including installation, calibration and maintenance of monitoring equipment), and stream chemistry.

Man and the Biosphere Program/US Forest Service – This is a jointly funded project to study dry deposition of N and S compounds at Elk Creek.

Electrical Power Research Institute (EPRI) – EPRI has recently contracted for a study of surficial geology and mineralogy of the Emerald Lake basin.

University of California – Special UC research funds for acid precipitation related topics have been acquired to supplement soil mapping and chemistry projects already begun, and for seed money for studies on effects of aluminum on mycorrhizae.

California Air Resources Board – The Air Resources Board has recently selected Emerald Lake as the site for a major 5-year integrated watershed study on the effects of acid precipitation on the Sierra Nevada. The ARB is funding several comprehensive studies, including aquatic systems (stream and lake chemistry, plankton, diatoms and invertebrates) at Emerald Lake, snow hydrology and chemistry at Emerald Lake, vegetation studies (succession, mycorrhizae, lichens, productivity etc.) at Emerald Lake and Log Meadow, tree ring analyses, soil processes at Emerald Lake, and a study of lake sediment buffering.

NASA – As part of its Global Biology Program, NASA-Ames (Moffett Field, California) is funding three studies related to the integrated ecosystem project. These are designed to help predict basic ecosystem parameters from remote sensing data. They are examining forest biomass and productivity in the mixed conifer zone, and litter and soil nitrogen processes at Log Meadow and Elk Creek; and producing a topographic drainage model of Emerald Lake basin.

An additional study of N_2O emission from the soil is being planned.

Southern California Edison Co. (SCE) - SCE is funding event precipitation chemistry collection sites near Elk Creek and Log Meadow, and a survey of water chemistry of High Sierra lakes.

National Atmospheric Deposition Program (NADP) - NADP has an acid rain monitoring station (wet and dry buckets) that is part of the federal monitoring network located near Log Meadow.

Oak Ridge National Laboratory, Tennessee - Oak Ridge is carrying out a study of the use of Be_7 as a tracer of dry deposition in the mixed conifer zone.

CLOSING THE GAPS

Although the high level of interest and support by federal, state, and private entities has been gratifying and productive, several significant program elements are not yet being attended to. These include: 1) nutrient cycling and soil microbiology, to complete the nitrogen model initiated by NASA; 2) experimental laboratory modeling of long-term acid precipitation effects on soils, to help anticipate the effects of present or projected precipitation chemistry regimes; 3) fish and amphibian population dynamics; 4) terrestrial arthropod baseline inventory, to be done intensively in several representative vegetation types and then monitored periodically; 5) completion of standard soil maps of the Parks; 6) reconstruction of biological history to provide a range of normal variation against which changes may be judged; and 7) examination of the effects of ozone on species other than man, yellow pines, black oaks, and sequoias.

It is unlikely that any manager ever will have all of the information that should be brought to bear in resolving resource problems. Decisions constantly must be made with far less data than should be at hand; and conversely, inaction is often excused by the lack of data. Because the ecosystem approach has been taken in developing Sequoia and Kings Canyon's air pollution research program, the severity of those quandaries of management is being substantially reduced--not only as it relates to dealing with air pollution, but with the whole array of contemporary and future assaults on the Parks' ecosystems' integrity.

AIR POLLUTION WORKSHOP SUMMARY

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Participants in the workshop unanimously felt that the main emphasis of an air quality program for a biosphere reserve should be on research and monitoring, with education and interpretation as secondary goals. Therefore, the workshop focused mainly on the nature of the air quality research and monitoring for biosphere reserves. A few thoughts on interpretive activities were also presented. Futhermore, although the discussion was intended to refer to biosphere reserves in general, the prevalence of U.S. National Park Service personnel in the workshop and the initial orientation toward Sequoia and Kings Canyon National Parks resulted in a discussion that centered primarily on the application of the biosphere reserve concept to U.S. national parks.

Research and monitoring activities appropriate for biosphere reserves are, for the most part, also appropriate for national parks. Biosphere reserve designation primarily adds a regional and global perspective. Air quality research and monitoring for national parks is geared almost exclusively toward the protection of park resources. In a biosphere reserve park, a broader program is called for.

The object of a biosphere reserve is not only to protect the resources within the reserve, but also to learn more about the biosphere as a whole. To this end, the biosphere reserve serves as both an area representative of a larger biotic province and an area against which to compare and contrast less pristine areas. Comparisons with other reserves with both similar and contrasting ecosystems are also an important function of the biosphere reserve program.

For these reasons, air quality research and monitoring in biosphere reserve parks should include a substantial outward-looking element. Monitoring should be geared not only toward providing the necessary data for park management, but also toward providing a baseline against which non-reserve areas or areas in other parts of the world can be compared. In many cases, this will make little difference in a program. In other cases, it could mean the monitoring of parameters that are not considered important from the park's standpoint in order to provide a baseline for comparison with other areas where they are important.

Similarly, research programs should be geared not only to providing information for park management, but also toward use of the relatively pristine reserve area for research that can be applicable to outside areas. Biosphere reserves can also be useful in providing an "early warning system" for anthropogenic effects that might be more difficult to detect in areas affected by the confounding influences of multiple use or development.

One of the most important ways to implement this difference in perspective is to develop cooperative programs involving other areas. These programs could involve companion biosphere reserves, nearby non-reserve areas, or other reserves in other parts of the world. Formally defined relationships are likely to be stronger and more durable than ties based only on informal cooperation.

For this kind of inter- area cooperation to be meaningful, it must be possible to compare the available data. Although this is important for national parks as well, biosphere reserve research/monitoring programs must be even more concerned with making their data compatible with that collected in other areas. Methods and data formats must be as standardized as possible. A high quality database must be maintained with an eye toward long-term storage, and the data must be accessible to outside researchers. One of the best ways to ensure this compatibility is to use established monitoring networks, such as the National Atmospheric Deposition Program (NADP) in the U.S. and the Global Environment Monitoring System (GEMS) of the United Nations. Periodic meetings of biosphere reserve managers and scientists for standardization of methods, exchange of ideas, and planning of cooperative programs would also be valuable.

Up to this point, it may seem that biosphere reserve designation is simply an additional burden which, if it does anything at all, will drain resources from park-oriented programs to those with less obvious benefits. To a degree, this is true. But biosphere reserve designation can also help park programs. The biosphere reserve label can improve chances for the funding of programs beneficial from both park and biosphere reserve viewpoints. It may also have considerable rhetorical value, giving extra weight to park protection in air quality permit proceedings, design of regulations, and other political and legal machinations of the air quality regulatory process.

The cooperative programs and broadened perspective developed under a biosphere reserve program can also directly benefit park management. Manipulative research not appropriate for a national park can be carried out more easily in nearby areas because of ties developed under the biosphere reserve concept. Air pollution-related damage to less pristine areas may also give added weight to park managers' claims that their areas are in danger. A graphic example of this is the widespread ozone damage to trees in the San Bernardino Mountains and the effect it has had on the perceptions of potential damage in Sequoia and Kings Canyon National Parks. While the biosphere reserve status is not essential to these comparisons, it does give added impetus to developing the ties and keeping aware of what is going on outside park boundaries.

Additional specific suggestions given for the kinds of research and monitoring that should be undertaken in a biosphere reserve include:

1. A heavy emphasis should be placed on baseline data collection and monitoring. This is essential not only for inter-area comparisons, detection of trends, and legal proceedings, but also for interpretation of more detailed effects research.

2. Past research and monitoring activities should be reviewed for any potentially useful data sets. A good historic record would be invaluable in interpreting current work and current pollutant levels and pollutant effects.

3. Experimental effects research is also essential. Such research should initially concentrate on the most clear-cut cases of air pollution damage. These may not be the most important effects, but they are likely to be the most effective in generating public support.

4. Both ecosystem-oriented and organism-oriented research are important. Because the biosphere reserve program stresses the importance of preserving genetic diversity, all species should be included, not just the community dominants.

5. Trajectory modeling aimed at clarifying source-receptor analysis is an important element. Research and monitoring programs should not lose track of the legal framework within which they must operate. They must be tailored to provide the kinds of data needed by regulatory programs, and the quality of that data must be good enough to stand up in court and in permit proceedings.

6. Finally, a biosphere reserve monitoring program should include parameters such as carbon dioxide and its relationship to the global climate, which may be important from the global perspective but not the local.

Although the workshop gave little attention to interpretive and educational programs, it was generally agreed that such programs were valuable. Information on air pollution should be included in interpretive displays. Traveling displays can be used in areas outside the park to further increase public awareness. Public participation in decision-making should also be encouraged whenever practical.

Such programs should not be seen only as a service provided by the biosphere reserve park, perhaps at the expense of other services. Interpretive programs are also effective in generating public support for park or reserve programs and public concern about the effects that air pollution may be having both within and outside park boundaries.

Finally, the workshop addressed several institutional constraints that limit the ability of parks to implement biosphere reserve-oriented activities. Foremost among these is the lack of a program identity for the "biosphere reserve program." Without personnel or funding specifically allocated to biosphere reserve activities, any such activities undertaken by a park come directly out of the budget of some other, established program. Given current limitations on park budgets, it is unrealistic to expect any substantial reallocation of funds from more traditional programs.

Along the same lines, the need for a central agency-level policy with regard to biosphere reserves was strongly felt. Although it is possible to reorient some programs to reflect a biosphere reserve perspective, any changes involving substantial reallocation of funds are unlikely to be made at the individual park level. Some commitment must be made by the NPS leadership. The objectives of park management must formally include biosphere reserve objectives before the kind of commitment the program calls for is likely to develop. Hopefully this workshop has been a step in that direction.

EXTRACTION OF NONRENEWABLE RESOURCES IN BIOSPHERE RESERVES: AN OPPORTUNITY TO MEET THE NEEDS OF MAN AND NATURE

Thomas W. Lucke[1]

Abstract. The MAB program offers conservationists and the extraction industry an opportunity to meet the twin goals of resource preservation and extraction. MAB areas, where mining and preservation coexist, can serve as experiment stations or laboratories in which processes and procedures can be developed to integrate conservation and development. These concepts could then be exported so that extraction activities, no matter where they occurred, would be accomplished in an environmentally sound manner. The goal would be to bring about a human landscape on which extraction, undertaken to meet human needs, would be controlled and would not result in the destruction of ecological diversity.

PROBLEM

The world of today needs to preserve gene pools. It needs to preserve ecological diversity. It needs to protect its endangered species such as the grizzly bear, the black-footed ferret and the peregrine falcon. It must have the foresight to protect valuable natural habitat from becoming islands in an expanding sea of development. That on the one hand. On the other, the world and its ever-expanding population needs iron to build its machines and fuels (oil, gas, coal and uranium) to drive those machines. It needs strategic minerals to allow us to conquer outer space and to feed our industry. Both needs are real, both are important. One policy option speaks to resource preservation; the other speaks to the extraction of nonrenewable resources. Can we have both extraction and preservation? Or, must we decide to have either one or the other?

In the past, unfortunately, confrontation was the order of the day. Preservationists were pitted against the extraction industry. Developers became locked in battle with conservationists. It was a win-or-lose situation. Victory was on the side of whoever could muster the most money and the most influential supporters. In some cases, the extraction industry won at the expense of resource preservation. In other cases, preservationists won at the expense of resources badly required to meet the energy and strategic mineral needs of the world and its peoples. In short, decisions were made on the basis of "might made right."

This type of confrontational decision-making was tolerable in days when we lived in a world of plenty, a world where we could both "lock up" some resources and "extract" other resources. But, those days are rapidly coming to an end. Our population is increasing, and our needs for oil, gas and minerals are increasing. When the last barrel of oil is below a national park, when the last pound of cobalt is within a national preserve, or when the last ounce of molybdenum is to be found in an archeological preserve, the confrontational politics of the past will not work. Those nonrenewable resources will be extracted to feed the hungry, to clothe the naked and to care for the poor. The conclusion is foregone! Those resources will be extracted to meet human needs. What legislators will say "PRESERVE" when their constituents are hungry?

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What Presidents or Prime Ministers will say "CONSERVE" when their people are cold? What voters will favor "NO DEVELOPMENT" when they have no jobs and their children are denied the necessities of 20th century life?

But, to say that it is inevitable that the extraction of nonrenewable resources will occur is not to say that we must totally destroy our natural world in doing so. Rather, we must develop a system to allow for the extraction of certain nonrenewable resources while still preserving key natural resources. We must create an atmosphere in which conservationists and members of the extraction industry can work in harmony to ensure that both extraction and preservation goals are met. We must develop a system that allows both to become prudent stewards. And, I feel it is in this arena that the Man and the Biosphere Program can make a great contribution. Unlike core preservation areas, MAB areas can provide the opportunity for the conservation community and the extraction industry to work hand-in-hand and to serve as a role model for the rest of the world.

STATUTES AND LEGISLATION

But, before I speak to that point, let me give a brief overview of what type of extraction activities have occurred throughout the history of the park system in the United States. Many observers of the National Park Service are not aware of the full extent of mineral development within units of the system. It is not a topic that is dear to the hearts of people who concentrate mainly on the preservation and conservation of resources. Yet, the activities are real (Hamson 1982).

For example, five national recreation areas were established with specific provisions in their enabling legislation that permit the leasing of Federally-owned minerals. The five areas are Lake Mead, Glen Canyon, Ross Lake, Lake Chelan and Whiskeytown-Shasta-Trinity. As with other public lands, the leases within these recreation areas are issued by the Bureau of Land Management under various sections of Title 43, Code of Federal Regulations.

In the 1960s and 1970s, Congress established a number of park units in which it explicitly authorized the extraction of oil and natural gas by the subsurface owners. In these areas, only the surface estate was acquired by the National Park Service; the owners of the subsurface rights were allowed to retain ownership and are allowed to extract the oil and gas deposits. Examples of such areas are Big Cypress National Preserve, Fort Union National Monument, Padre Island National Seashore, Big Thicket National Preserve and Jean Lafitte National Historic Park. The regulations governing the extraction of non-Federally owned oil and gas deposits can be found in 36 CFR 9, Subpart B.

Upon establishment as part of the National Park System, individual units are generally closed to mineral entry under the General Mining Law of 1872 (Novak 1982). However, Congress expressly permitted continued mineral entry in six areas: Death Valley National Monument, Glacier Bay National Park and Preserve, Crater Lake National Park, Mount McKinley National Park (now Denali National Park and Preserve), Coronado National Memorial and Organ Pipe Cactus National Monument. In 1975, mineral entry received national attention when a series of mining claims were staked on some of the most popular scenic lands within Death Valley National Monument. As a result, Congress passed the Mining in the Parks Act of 1976 (Public Law 94-429). While the Act closed all of the six units to further mineral entry, it authorized the Secretary of the Interior to promulgate regulations governing the extraction of minerals by the individuals and companies who held valid existing rights (36 CFR 9, Subpart A).

The above are a few examples- not an exhaustive list- of the various types of extraction activities permitted throughout the National Park System. You will note that three of the NPS areas mentioned, Denali National Park and Preserve, Organ Pipe Cactus National Monument and Big Thicket National Preserve, are already MAB areas, and the U.S. Department of State has recently requested NPS endorsement of Death Valley National Monument to become part of a Desert Biosphere Reserve.

This brief overview shows that the U.S. Congress, in the past several decades, has come to the realization that the United States cannot survive and continue to prosper without oil, gas, minerals and other extractable resources. Yet, Congress saw the real need to preserve key natural resources. So, Congress devised a scheme whereby the staff of the National Park Service would be charged with the triple responsibility of preserving key resources, providing for appropriate visitor enjoyment, and allowing for oil, gas and mineral extraction to continue in order to meet the energy and critical mineral needs of the country. In a real sense, the Congress of the United States, for whatever reasons, chose to combine altruism and materialism with the hope of capturing the true public interest.

Permit me to say that I am not advocating the opening of National Park Service areas to mineral development. Clearly, that would be inappropriate. I am not advocating the opening of any park area to extraction. The world needs areas of total preservation. What I am saying is that the U.S. Congress mandated both preservation and extraction in some units of the system. In these areas, and in MAB areas around the world where the twin activities have been legitimized, we should make a concerted effort to ensure that both mandates are met and that the techniques developed there should serve as a model for environmentally sound mineral extraction projects. Let me explain what I mean.

ONE POSSIBLE SOLUTION

The MAB program and its staff, in my opinion, should develop a specific program to expand on and apply these twin goals of idealism and materialism. The purpose of the program would be to develop the knowledge, technologies, institutional and practical skills required to enable people and governments in every part of the world to integrate the extraction of nonrenewable resources and the preservation of key natural resources into one system in order to work in harmony and to meet both goals (Batisse 1982).

While the thought of allowing for extraction of nonrenewable resources while preserving natural features in the same place may be relatively new, the concept of productive coexistence between conservation and development has begun to receive serious attention. The IUCN's landmark publication in 1980 outlining a world conservation strategy focused world attention on the concept, giving it both credibility and direction. This publication marked a turning point in global conservation policy, away from the traditional focus on protection of significant natural areas and toward a broader approach in which the marriage of conservation and development is seen as an essential prerequisite of human progress (Gregg 1983).

And, because it is a new concept, traditional park managers and particularly park scientists will have to be prepared to deal with a whole set of new problems, problems that do not fall into the traditional category of preserving our sacred ungulates or counting peregrine falcon nesting sites. Disposal of drilling muds, possible subsidence, acid drainage from mines, diminution of air and water quality, and impacts of drilling rig noises on nesting waterfowl are examples of the types of technical issues that need to be addressed. These are not the types of studies that the average park scientist has been trained to handle or is temperamentally inclined to pursue.

However, some significant on-the-ground steps have been taken with some positive results. For example, oil and gas exploration in Big Cypress National Preserve had a one-year moratorium imposed in 1983 by the Governor of Florida, and it was coupled with a Task Force to recommend interagency mitigating actions. Today, exploration and extraction requires the review and monitoring by the Big Cypress Swamp Advisory Committee, Florida Department of Natural Resources (well and drilling permits), Florida Department of Environmental Regulation (water monitoring and wetlands protection), and the National Park Service (surface landowner). Other agencies more peripherally involved include the Florida Game and Fresh Water Fish Commission, South Florida Water Management District, and county environmental offices. Permitting takes a minimum of six months, but, when that permitting process has been completed, extraction activities are controlled and well thought out. In short, it is a rational approach to land use planning.

Core preservation areas are, of course, needed. But MAB areas where both extraction and preservation coexist are also needed. These latter types of areas could serve as experiment stations or laboratories to find ways to integrate conservation and development within each of the diverse ecological regions of the world. Such MAB areas could serve as the catalyst for bringing conservation fields to develop techniques and build skills that could then be applied at the local, regional, national and international levels. The extraction capacity of different ecosystems could be established, innovative drilling/mining tools could be devised, environmentally sensitive transportation modes could be developed, non-destructive survey/exploration devices could be instituted, and our methods of restoration and reclamation could be refined. These and other products and processes developed by a concentrated effort within the MAB areas could then be exported so that extraction activities, no matter where conducted, would be accomplished in an environmentally sound manner. These MAB areas could set the standards and become the cornerstone for conservation wherever in the world human needs and demands dictate that resource extraction occur. In addition, local, State and Federal governments could use these techniques and standards as their benchmark in developing new laws and regulations. If this did occur, the people of the world could look forward to a time when they could see natural resources preserved on the landscape where they spend most of their lives and not see it only when they visited a park or protected area. The conservation of natural diversity would become a part of their everyday life and would not become a rare curiosity to be enjoyed only during a visit to a protected area. Such a program would help attain the World Conservation Strategy:

> "Conservation is the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment."

Such an international program is necessary. And, it is imperative that such a program commence soon. If it does not, there is a real danger that the conservation community and the extraction industry, like the infamous Kilkenny cats of Ireland, will keep clawing, scratching and biting at each other until there is nothing left of them but their tails (Dasmann 1972).

Instead of conflict, managers of such MAB areas could work closely with various existing institutions to evaluate existing techniques, technologies and laws. As a nation, the United States is becoming more and more sophisticated in its bio- or

ecosystems monitoring and manipulation, but it has a long way to go if extraction and preservation are to live in harmony. And, because our present system is not perfect, various entities are striving to improve methodologies and laws. As an example, the Office of Technology Assessment, U.S. Congress, is presently undertaking a study of Technologies for Surface Mine Reclamation in the western United States. Other entities involved in studies to ensure that extraction is accomplished in an environmentally sensitive manner include the American Petroleum Institute, the American Mining Congress and the research offices of various mining companies. The MAB program, as proposed here, could work closely with such groups to ensure that natural resource concerns are integrally woven into the fabric of such reports and studies and that extraction is carried out under strict guidelines that would allow the land to revert to its natural state.

In this day and age, conservationists cannot afford to be optimists. Yet, to be a pessimist is to be a defeatist. To me, that is not a viable option. Let us work to develop a program under which can occur mineral extraction to meet the needs of the world community and preservation activities to ensure the continued ecological diversity for viable natural habitats. This would be a logical extension of the MAB mission; this would be a response to the needs of the late twentieth century in the same way the setting aside or preserving of core areas was a response to societies' needs earlier in the twentieth century. And, such a program would lead to a rational approach to resolving the conflicts between preservation and development; it would lead to a policy of orderly and careful development rather than to a crash program when the needs are immediate and environmental cautions are left unmet and preservation questions unanswered (Riggs 1984).

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DEVELOPMENT OF NONRENEWABLE RESOURCES AND GLACIER NATIONAL PARK

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Abstract. Glacier National Park, Montana, has been identified as the most threatened national park in the National Park System. About half of the threats are external and many have the potential for considerable long-term resource alteration. This paper examines case studies of two of the more significant issues and seeks a course of action through the Man and the Biosphere Program.

INTRODUCTION

Nearly 75 years after its establishment, Glacier National Park, Montana USA, faces numerous internal and external threats to its integrity as a natural ecosystem. Some of these threats are internal and are presently producing adverse impacts for which the park is providing mitigation measures, i.e., visitor impacts, fire management, exotic plants, construction and maintenance projects. Others are external threats of far-reaching potential magnitude.

The Man and the Biosphere (MAB) Program may play a leading role in providing mitigation to the potential external threats resulting from proposed development and extraction of nonrenewable resources adjacent to Glacier National Park.

This paper will focus on two issues. (1) Oil and gas exploration and production on public lands in the U.S. adjacent to the park has some interesting and challenging relationships. (2) A proposed open strip coal mine operation in British Columbia has unique international implications.

Stratagies developed to protect the integrity of Glacier National Park through the Man and the Biosphere Program will have application elsewhere.

THE RESOURCES

Glacier National Park has existed since 1910 as a natural ecosystem that must be considered one of America's most valuable nonrenewable resources. An area of one million plus acres--slightly larger than the State of Rhode Island--it is surrounded by several million acres of essentially public land. On the east it is bordered by the Blackfeet Indian Reservation and on the south and west by two national forests. Small tracts of private, state and county lands exist nearby. The northern boundary against British Columbia borders Crown land, while the boundary against Alberta joins Waterton Lakes National Park, linked to Glacier to form the world's first International Peace Park. The complex geologic landscape of Glacier is displayed in a spectacular combination of precipitous peaks, glacier-carved valleys and mountain lakes, and glaciers. This ever-changing land, complimented by a diverse biotic community, represents a major scientific resource, as well as an aesthetic recreational attraction of national significance.

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Today, Glacier remains remarkably intact ecologically. Only two mammals no longer exist- the bison and the caribou. The park contains a vast wild area and is playing a leading role in the preservation of the threatened grizzly bear and the restoration of the endangered bald eagle. The park also provides a safe haven for the northern gray wolf that now frequents remote, seldom-used areas of the park.

Waterton Lakes National Park was established in 1895 and is one of only two biosphere reserve areas presently set aside in Canada. It is bordered by Crown land, the Blood Indian Reservation and private ranch land. The meeting place of mountain and prairie landscapes, the area was set aside to preserve its scenic beauty and its many natural and archeological features and to allow for the natural evolution of park ecosystems, while providing facilities to enhance the visitor's enjoyment of the park.

The U.S. Forest Service's (USFS) Coram Experimental Forest Biosphere Reserve and Research Natural Area (5 miles south of Glacier National Park) forms the third link in this chain of biosphere reserves. The area is an outdoor laboratory for silvicultural research and provides the basic information needed to manage western larch and Douglas fir forests on comparable sites in the Northern Rocky Mountains. The Research Natural Area is used only for monitoring while the remainder is available for manipulative research. The area is subject to oil and gas exploration and development as a permitted activity.

Waterton, Glacier and the USFS Coram Experimental Forest have each been designated as Biosphere Reserves. Recently, the Regional Forester and the Superintendents of the two parks have agreed the three areas should be redesignated as the Rocky Mountain International Biosphere Reserve.

OIL AND GAS EXPLORATION

The forces that created the Lewis Overthrust provided the spectacular landscape that resulted in the creation of Glacier National Park. These forces also created the potential for major oil and gas reserves that may help in retaining the good life we know in America today. In addition, exploration and production on tribal land can enhance the well-being of our native Americans, and on State lands it can provide income to the public schools of Montana.

Currently, major exploratory wells (representing a $4 million-plus investment) are proposed on the Lewis and Clark National Forest, four miles from the park boundary, and on the Coal Creek State Forest, 1-1/2 miles from the Flathead Wild and Scenic River on the western boundary of Glacier. Both are under the mandates applicable to their management. Both have proposed to move ahead on the basis of Environmental Assessments. The U.S. Forest Service and the Montana Department of State have provided complete briefings to the park staff, but wish to avoid full Environmental Impact Statements because of the considerable cost, time delay, and unknowns and the small chance of an exploratory well becoming a producing well. The park has pleaded the case that all of the potential impacts should be addressed up front. To allow the permittee to expend over four million dollars in exploration and then discover the environmental cost to develop is too high, would be irresponsible. If four million dollars is to be spent on a risky venture, then funds should be found for an adequate assessment.

The potential impacts to the park are scenic degradation, noise pollution, air and water pollution, increased access to remote areas, and human intrusion on grizzly bear and wolf habitat. The secondary impacts (in the form of more people and more development of critical migration corridors in the buffer zone of influence adjacent to

one of the world's biosphere reserves) would probably be more severe than the impacts from the extraction process facilities.

Our philosophy is not to be a barrier to development, but rather to make our concerns known and work with our neighbors to mitigate negative impacts and create sound development that will have minimal adverse influence on the park's natural ecosystem. Working with--rather than against--always pays larger dividends to all concerned.

The park was instrumental in the establishment of the "North Fork Coordinating Committee," composed of all area land and game management agencies. This Committee provides a forum for the discussion of oil and gas exploration and development and other similar issues along the western boundary of the park. The Committee has served as a communication link to develop understanding, share planning efforts, and hopefully lead the way toward some form of regional planning. Tribal and Bureau of Indian Affairs spokesmen have been less open about their plans along the eastern front.

The park's science and resource management staff works directly and closely with other agency personnel involved. These and other threats--both internal and external--are also woven into the park's interpretive programs.

CABIN CREEK COAL MINE

Sage Creek, Ltd., a subsidiary of Britain's Rio Algam, Ltd., has proposed an open pit coal mine development in the southeast corner of British Columbia, six miles from the northwest corner of Glacier National Park. Extensive deposits of low sulphur coal are destined for Far East markets for production of heat and electricity. The predicted active life of the mine is from 20 to 40 years, producing 2.2 million tons per year from the 4,000-acre site. It would be ironic, indeed, if coal harvested here and shipped to the Far East came back to Glacier in the form of acid rain because of the lack of environmental controls at the source of use. This observation is only to suggest the complexity of some of the potential impacts that face biosphere reserve areas. The potential local impacts are high because of the site's location in the Flathead River Basin system, which flows south across the border along Glacier's western boundary into Flathead Lake--the largest natural freshwater lake west of the Mississippi River. Adverse impact on aquatic resources would have severe economic repercussions as well as potential irreparable ecological damages. Class I air quality designation for Glacier provides protection on the U.S. side of the border, but this classification is not international. Other potential impacts of boundary encroachment from a major facility this close to the park are major road developments for transportation of the final product, air quality degradation, temporary townsite and subsequent day-use facilities for several hundred workers, settling pond overflows and flooding, ground water degradation and nearby homesite growth. Benefits would accrue to the economy of British Columbia residents--most of whom live in the opposite end of the province--and who remind us that we enjoy the benefits of our resource development and they seek the same good life. International negotiations on this issue have been intertwined with diversion projects originating in the U.S. and flowing into Canada--the Poplar River Project between Montana and Saskatchewan and the High Ross Dam at North Cascades National Park--and the effects in Canada of acid rain generated in the U.S.

In spite of these complex issues, the park has been able to meet with Provincial and Federal Canadian officials to discuss our concerns. In this respect, the U. S. State Department, Montana Governor Schwinden, and Montana Senator Baucus have provided

invaluable assistance and leadership since the potential impacts reach beyond the park and come under the International Boundary Treaty of 1909, which says that neither country will degrade the waters of the other country-- but who sets the degradation standards is still unclear.

The issue has resulted in the establishment of the Flathead Basin Commission by the Montana State Legislature. The Superintendent of Glacier serves as a member of this Commission. The Commission's purpose is to protect the natural resources and environment of the Flathead Basin by coordinating development of an annual monitoring plan and developing strategies among agencies to encourage economic development without compromising the environment.

Discussions with Provincial and Canadian officials under the State Department leadership have relied on the International Boundary Treaty and the International Joint Commission (IJC) because of its legal status as a treaty between the two countries.

The U.S. State Department has been reluctant to lean on the biosphere reserve designation of Glacier as a lever because it lacks any legal status. Impending proposed designation of Glacier as a World Heritage Site may carry more weight because of its treaty provisions.

The encouraging aspect in this case is the open communications that have been developed with Canadian officials, their willingness to share their data and discuss objectives at the border, and their concurrence in a joint reference to the IJC to request a full study and recommendations from that two-nation commission.

EXISTING PROGRAMS

The broad program elements under development in Glacier include the following:

1. Broaden existing area of management cooperation to include regional terrestrial and aquatic ecosystems.

2. Establish an advisory committee to assist park management in program content and direction.

3. Refine present monitoring programs to assure that all elements of the park environment are adequately treated.

4. Conduct a genetic evaluation of species in need of special attention.

5. Tie a portion of the park's research budget to biosphere reserve activities.

6. Provide information/interpretive programs to develop public understanding and support.

7. Accelerate implementation of Regional Landsat Geographic Information System.

8. Initiate comparative study work using elk winter range as a prototype model.

9. Allow use of park's gene pool for enhancement of endangered or threatened species-- i.e., west slope cutthroat trout and grizzly bear.

10. Through the recently formed Glacier Institute--an educational alliance with the Flathead Valley Community College--provide educational classes on the Man and the Biosphere Program.

11. Establish a local MAB trust fund and grant program for student research on MAB-related projects.

Current examples of research and monitoring activities within Glacier National Park Biosphere Reserve include:

- Possible grizzly bear augmentation plan for Cabinet Mountains (use of Glacier's gene pool for grizzly bear recovery.

- Development of Regional Geographic Information System.*

- Air quality monitoring, including acid rain and a bio-indicator network. (One of three Canadian acid rain monitoring stations in the U.S. is in Glacier.)*

- Baseline study of heavy metals and other pollutants.

- Water quality monitoring parkwide and on North Fork at Canadian border.*

- Mount St. Helens nutrient subsidy studies.

- Baseline wildfire behavior and ecology studies.

(Projects marked with an asterisk [*] relate to the two issues discussed in this paper.)

Glacier has not identified line-item budget allocations or personnel to MAB-related projects. Rather, employees from several disciplines have become involved, including management, interpretation, resource management, planning and research.

In 1982 Waterton Lakes National Park established a Biosphere Reserve Management Committee that includes local neighbor ranchers. The active group has provided direction for the program and has received modest financial help through Canada/MAB and Parks Canada ($2,000 - $3,000/year). They have more recently established a technical committee with representation from several federal and provincial agencies, including a member from Glacier's research staff.

The five-year objectives of the Waterton Lakes Biosphere Reserve are as follows:

1. Work with the Natural History Association to establish a biosphere reserve publications series.

2. Establish demonstration research projects for public viewing.

3. Establish a regular series of seminars on biosphere reserve issues.

4. Set up an education and research program for secondary, college, and university students.

5. Establish a long-term environmental monitoring program in cooperation with Glacier Biosphere Reserve and the Coram Forest and Range Experimental Station.

The Coram Experimental Forest is engaged in the following studies:

1. To establish desired mixtures of natural or artificial regeneration rapidly after harvest cuttings.

2. To determine the effect of various stand cultures on the development of these forests.

3. To reduce insect and disease problems through silvicultural practices.

4. To determine the biological and economic effects of wood utilization practices.

5. To enhance watershed, esthetic, and wildlife habitat values through silvicultural practices.

6. To establish permanent plots to study terrestrial vegetation in research natural areas.

Designation of the Rocky Mountain International Biosphere Reserve will give added emphasis to closer coordination and cooperation between the parks and the experimental forest.

CONCLUSION

The program is not well understood by the public, and consequently there has been some tendency to use the biosphere reserve status as a hammer to impede resource development. We have been slow to develop well-defined biosphere reserve action plans that address the objective of MAB, since the program is new and evolving and managers are still trying to determine how to incorporate it in their existing mandates. The guidelines are only now being formulated about what we can do in designated reserves to meet the objectives of the program.

We are in the midst of a learning and experimenting phase of a long-term program that should materially benefit the preservation of Glacier National Park's natural ecosystem while providing for the wise use of adjacent lands.

The issue at hand is, how can the MAB biosphere reserve designation be used to develop measures that will be supportive of other agency mandates to develop natural resources for the benefit of the people, while at the same time protecting the integrity of the natural ecosystem of the park--also for the "benefit and enjoyment of the people"?

DEVELOPMENT OF NONRENEWABLE RESOURCES
WORKSHOP SUMMARY

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Unknown to most people, twenty percent of National Park Service areas are open to some form of mineral resource extraction. Extraction rights may be in the form of federally-owned mineral rights, claims resulting from the 1872 mining act, or via nonfederally-owned oil and gas rights. Several biosphere reserves are affected by such internal extractions. Mineral extractions outside perserve boundaries affect even more national parks and biosphere reserves. Extraction operations may adversely affect biosphere reserves by acidic or toxic water drainage, air pollution, noise pollution, and/or increased human activity around the perserve boundary. Activities such as roadbuilding, logging, and home building may disturb animal migrations or movement or breeding behavior within the preserve, even when these disturbances occur outside the preserve. To address this problem, the workshop considered the case history presented by the Glacier National Park Biosphere Reserve, an area affected by mineral extractions outside its boundary.

Glacier National Park and Waterton Lakes National Park in Canada are contiguous and in close conjuction to Coram Experimental Forest. All are biosphere reserve areas and have asked to be collectively redesignated as the Rocky Mountain Biosphere Reserve. There are three current extraction proposals within six miles of this biosphere reserve. These are oil extraction on U.S. Forest Service land, oil extraction on Montana State Forest lands, and coal extraction amounting to two million tons yearly for 20–40 years on British Columbia Crown Lands. Since the extractions will take place outside the actual preserve and since there are strong economic incentives to develop these mineral resources, the issue becomes finding ways that the Biosphere Reserve Program can be used in a positive way to ensure that development proceeds without compromising the integrity of the reserve.

The discussion during the workshop emphasized that there is a general lack of understanding of the biosphere reserve concept and a tendency to confuse preservation of natural resources with nondevelopment of the area. Such a misunderstanding often leads to a lack of cooperation between industry and biosphere reserve officials. One way to reduce this misunderstanding may be to change some of the misleading or harsh terminology used by biosphere reserve officials. The term "buffer zone" implies a hard-line locking up of resources, while "area of cooperation" may actually lead to more cooperation between industry and the biosphere reserve. Ultimately, education is the key to reducing misunderstanding. Education of biosphere reserve concepts should be a priority of the MAB program. Often, even the MAB staff does not understand these concepts. We need to start educating our own personnel and expand this education to include visitors, the general public, local government, and industry. The educational program should focus on the mutual benefits of the MAB program and on ways that cooperation can be accomplished.

Associated with this lack of understanding is a nearsightedness on the part of MAB officials. There is a general failure to look beyond the boundaries of the reserve and detect problems such as nearby mining before they occur. It is much easier to prevent environmental damage than it is to clean up afterward. A system of monitoring

programs outside the reserve boundary would be an excellent first step in reducing this shortcoming. Establishment of water and air quality standards by using the reserve to provide baseline data is another way to prevent problems. Monitoring programs and establishment of standards are more likely to succeed if industry is allowed to provide input into their establishment. In addition, MAB officials should be directly involved in local and state government bodies that decide on local environmental issues. Such local planning and zoning committees are good places to air reserve concerns about nearby development and to educate the public about potential impacts.

Similarly, there is a lack of public involvement in the decision-making process within the biosphere reserve program. A concerted effort should be made to involve the public by holding public meetings on issues that affect the biosphere reserve and surrounding areas. This would not only present an aura of MAB cooperation, but would also educate the public to MAB concerns and MAB to the public's concerns. Public meetings of this nature would be excellent opportunities to compare the benefits of proposed development with the benefits of the natural resource. For example, tourism may be much more profitable for the surrounding area, especially in the long term, than a short-lived mining operation. Such meetings can become the first step toward a cooperative effort by the entire community to preserve the resource.

At the same time, however, while we are encouraging public support, we should also be encouraging support by industry. Industry, especially mining, has a strong economic incentive to develop the mineral resource. If we can provide strong incentives to protect the biological resource during the development of the mineral resource, we are much more likely to succeed than we would if we try to completely deny resource development. One method of encouraging the cooperation of industry is to work with them to develop the least destructive techniques for mineral extraction and to demonstrate how such cooperation can lead to positive public support for an often maligned industry. Another method is to use some type of incentive program to allow the development of one area in exchange for total protection of another particularly critical or sensitive habitat. Federal or State tax credits are another means of providing incentives for industrial cooperation in preserving natural resources.

In conclusion, managers of biosphere reserves need to provide leadership in using the MAB concept as a tool in the management of the reserve and the surrounding community. Such management should be based on the cooperation of all involved parties and should emphasize the benefits to all. Through education and cooperation, we can develop the needed natural resources and still preserve the biological resources represented in MAB areas.

BIOSPHERE RESERVES OF THE MAN AND BIOSPHERE PROGRAM IN SUPPORT OF SUSTAINED-YIELD FOREST MANAGEMENT

Stanley L. Krugman[1]

Abstract. Traditional methods of information and data gathering to support modern forest management are no longer adequate. The modern forest manager must be highly skilled in a number of technical areas; he must also be sensitive to the impact of his management decisions on the society and environment of which he is a part. The Biosphere Reserve Program offers a unique opportunity to focus diverse disciplines and skills on given natural resource management problems. This new research tool enables the resource manager to identify the consequences of his management on both the natural resource as well as on human activity and the local environment.

Additional keywords: Biosphere reserves, MAB, forest management, forest germ plasm management, environmental management.

INTRODUCTION

Forest managers must be highly skilled in the various technical aspects of forestry. They must also be aware of the impact of their decisions on the society and environment of which they are a part. Today's forester does not manage but one resource; he must, on a daily basis, come to grips with multiple natural resource management problems and decisions of both short and long-term duration. He must also be aware of those environmental factors over which he has no direct control, as they influence the direction his resource management may take. Clearly, current forest management is highly complex and getting more so each year.

Traditional methods of information gathering to support modern forestry are only partially successful and effective. New problems are surfacing faster than traditional information systems can respond. The scope of many forestry issues is no longer narrow and restricted to a local forest or region. They are often national or international in ramification. For example, air pollution as a result of man's activity has become an all too common trademark of an industrial society. Although the source of the pollution may be far removed from the natural resource for which we are responsible for managing, the influence of air pollution on the resource must be understood. The acid rain problem of northern Europe and the eastern United States has all too often a serious negative impact on the productivity of virtually all forest trees and resources. The acid rain problem is no respector of national borders, and will be with us for some time to come. Yet, in developing current management plans, we must consider possible losses in forest productivity from causes which we seem unable to directly control.

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NATIONAL AND INTERNATIONAL COORDINATION ON ENVIRONMENTAL PROBLEMS

The current methods of responding to environmental problems are often inadequate. Frequently, we lack the funding and expertise to seriously address the issues. What is needed are new approaches to problem-solving and environmental information-gathering systems which provide for both national as well as international cooperation as needed. We need improved mechanisms for information-sharing and research strategies which enable us to bring together in an effective format many diverse disciplines to focus on a given resource management problem. The new research approach must enable us to identify the consequences of resource management decisions on human activity as well as the environment. We need a system that can quickly and effectively provide the latest information to the land manager.

One approach that is being used involves the Man and the Biosphere (MAB) Program. The main objective of the MAB Program is to develop the basis within the natural and social sciences for the rational use and conservation of the biosphere and for the improvement of the relationship between man and the environment (U.S. National Committee, MAB 1977). In principle, MAB provides a formal interdisciplinary and intergovernmental mechanism for bringing together and coordinating diffuse national and international resource, conservation, and training activities.

ROLE OF BIOSPHERE RESERVES IN RESEARCH AND MONITORING ACTIVITIES

The United States Biosphere Reserve network has been developed to include representative sites from a wide variety of ecological conditions, all of which are influenced to some degree by the activities of man. There are research and monitoring opportunities which can be addressed at individual sites and by the network as a whole. Several specific levels of research and monitoring activities that are being addressed on the biosphere reserves include: (1) long-term baseline studies of environmental and biological features (e.g., flora, fauna) which are essential as bases for management of the area and for other research projects; (2) research designed to assist in determining management policies for the reserve; (3) experimental and manipulative studies (outside the core reserve area), particularly of the ecological effects of human activities, including forest management; (4) environmental monitoring; and (5) study sites for various MAB research projects. The relative emphasis on different research and monitoring activities obviously varies with the nature of the biosphere reserve and the data needed. In view of the broad research and monitoring activities envisioned for the Biosphere Reserve Program, it thus should be easy and logical to integrate the concerns of forest management in monitoring those activities that have individual importance to management of the forest resources and of the environment (Franklin 1977; Gilbert 1976; U.S. National Committee, MAB 1977).

As an initial step in designing a monitoring system, it is important to assess the nature of all existing environmental research on the biosphere reserves. The United States is inventorying climatological and physical-chemical parameters, species composition and making biomass measurements, and conducting fauna censuses at its established biosphere reserves. This knowledge of existing monitoring projects at each reserve is

useful in providing a much-needed understanding of the current U.S. sites and will supply the foundations for the orderly initiation of second generation activities, such as new research and management projects.

ASSESSING THE ENVIRONMENTAL CONSEQUENCES OF INTENSIVE FOREST MANAGEMENT

The proposed extensive coverage of the Biosphere Reserve network (at least one reserve per major ecosystem type) provides an ideal framework for the coordinated accumulation and synthesis of monitoring data from a wide array of forest management practices, and to evaluate their impacts on forest resources. Much environmental monitoring data are already being collected in association with ongoing research activities on the experimental forests designed to evaluate and develop improved systems of thinning, cutting, harvesting, logging. transporting. processing, etc. of forest products, but the focus on these monitoring efforts is often point-specific. Furthermore, the methodology for collecting such information often varies widely from one study area to another and over time. Thus, current attempts at standardization of monitoring methodology in the United States is essential to the widespread use of environmental data for multidisciplinary analysis by the international scientific community, as well as by other biosphere reserves in the United States.

Forest management often involves many complex integrated and non-integrated paractices that potentially may produce environmental disturbances which are felt on-site or off-site, and may persist only temporarily or for centuries. Some of the most apparent environmental disturbances have been associated with the thinning, harvesting, and clearing of mature forests to maintain sustained timber production and reproduction. Often accompanying these practices is the use of heavy mechanized equipment and a wide assortment of chemicals, such as fertilizers, insecticides and herbicides, which still have unknown effects of uncertain duration on the ecosystem in particular and on the environment in general.

The benefits and/or impacts of treatments are often measured on a wide range of ecosystem parameters, including hydrologic response, timber and forage yields, soil erosion and sediment production, water quality, scenic beauty, and the dynamics of insect, bird, small animal and big game production. Less subtle changes may result in the forest environment by alteration of species succession, reductions in soil productivity, or even by changes in the climate. These less subtle changes in the long run have more far-reaching effects on man's living environment than the more immediate, apparent changes.

In view of the increasing demand and impacts on the forest resources for various forest products and benefits, it is necessary to monitor these resources more effectively to avert potentially adverse environmental changes and overexploitation. Information obtained in monitoring can be used to understand more fully the structure and function of the forest ecosystems and their role in biospheric processes. It will be necessary to identify and sample those biotic and abiotic elements which should be monitored to reflect conditions and trends in each ecosystem type. The designation of baseline and impact sites is of the highest priority, even though the technology for complete monitoring of all parameters is not yet developed. Any substantial delay in initiating a

monitoring program, however, can result in lost opportunities to arrest the deterioration of forest ecosystems and the environment. The ultimate objective of these monitoring activities, of course, is to provide a rational framework for research and management decisions that will maintain the productivity of forest ecosystems and thus result in a satisfactory relationship between man and the biosphere.

CONSERVATION OF FOREST GERM PLASM

Forests represent a substantial genetic resource of considerable diversity and richness. But, this unique resource is not limitless and is being subjected to numerous pressures. The utilization of forest resources and the conversion of forest land to agriculture and urbanization are increasing. To foresters who are interested in the maintenance as well as the long-term genetic improvement of the forest crop, biosphere reserves offer both a new opportunity in advancing the science of forest tree improvement and a much needed, built-in safeguard for maintaining the genetic diversity of forest trees, which are subjected to intensive forest management. Intensified forest management directly affects the germ plasm resource by removing desirable genotypes, and indirectly by alteration of habitat which may be critical for their continued survival. Furthermore, in some areas, the native forests are being removed often to be replaced by exotics or non-local reforestation stock. This mixing of often unrelated gene pools during the reforestation of managed areas further erodes our ability to recover stable and well adapted parental lines (Krugman 1984, Oldfield 1984, Krugman and Stewart 1982).

It is apparent that if forestry is to avoid the difficulties of general agriculture (i.e., the loss of the original genetic base), strategies must be developed to maintain a reliable and varied genetic reservoir for future improvement, to provide standards for progress in improvement, and to ensure and perpetuate selected large or small populations for future mass seed production. There needs to be a real concern for maintaining ancestral lines, as well as a broad genetic base for future selection and breeding programs. Maintaining an adequate diversity of genes in a population permits new combinations that can result in individuals that are better adapted to specific environmental situations. Through breeding, new combinations that fit specific criteria, such as disease resistance, rapid growth and drought tolerance, can be produced.

Currently, a number of strategies are being applied in a serious effort to maintain and protect forest gene resources. Among the more common methods are: seeds, pollen, and tissue culture storage, seed stands and plantations, seed orchards and arborea plantings, and special gene pool reserves (forest genetic reserves). The importance of each of these special management areas in protecting the germ plasm pool for important forest tree species is readily recognized by most forest managers (Krugman 1984).

The management of forest genetic reserves could be easily integrated with the management of biosphere reserves. These forest genetic reserves represent special areas of natural forest ecosystems, in which both static and dynamic management can be applied. To be effective as a genetic reserve, a biosphere reserve must include forest ecosystems that are representative of forest gene pools commonly found in areas where consumptive forestry is practiced and will be practiced, and where other pressures on the forest ecosystem may seriously modify this genetic composition. It also should be possible within the reserve to manage and manipulate given forest ecosystems (Krugman 1984).

The gene pool of a natural forest population is in adaptive and dynamic balance with a given environment and can only be maintained through successive generations within the environmental context in which it evolved. And, since the patterns of inherent variation of forest trees reflect the patterns of environmental variations, it is essential that as many patterns of environmental variations are included in a Genetic Reserve System as possible. Thus, their size should reflect the extent of the biological and environmental variation encountered. Most often, the Genetic Reserves must encompass extensive forested areas. Lest we forget, the area should be sufficiently large to minimize the hazard of foreign pollen contamination. Included should be those stands that are highly unique and exceptional in growth and form, as well as the typical representative stands of the areas. In addition, the sensitive and often unique transition zones of the various species should also be included. Distinct forest tree populations threatened with destruction should be a part of the Genetic Reserve.

Many of the current attempts at gene pool conservation are static systems. They are directed at arresting the present rate of evolution (i.e., permit fire control). Similarly, all too often under undisturbed forest conditions, shade-tolerant species are at a distinct disadvantage and can be eliminated. Yet many of these same intolerant species are a major source of the current and future supply of wood and fiber. It should be possible, by proper management (i.e., fire, logging, planting), to maintain repeatedly a segment of a Genetic Reserve in a halted successional sequence (Maini, Yeatman and Teich 1975; Yeatman 1972).

I noted earlier there is a serious problem of recovering and maintaining proven forest tree seed sources. By permitting mass seed collections, the genealogical pedigree of a seed source can be guaranteed, which in this day of declining intact gene pools is rather important to modern forestry. In essence, selected portions of a Genetic Reserve would serve as a tested, reliable, and varied genetic reservoir for perpetuating selected populations for forestry and related uses. In fact, certain portions of the Genetic Reserve should be preserved intact after the initial screening has taken place.

These recommendations for possible forestry uses of the biosphere reserves are not in conflict with the general philosophy of the system. To the contrary, the Biosphere Reserve effort is strengthened if the system can meet these forestry challenges in gene pool management.

INTERNATIONAL PROGRAM

The organizational mechanism is available under MAB-8 for an international effort of information-sharing. Already, planning teams representing the U.S. and the U.S.S.R. biosphere reserve programs have developed action plans and concrete proposals. To date, the main areas of mutual cooperation have been directed to (1) "monitoring and research aimed at understanding the structure and functions of ecosystems and their components," (2) "environmental consequences of various land management practices," and (3) ensuring the effectiveness of biological reserves in maintaining biotic diversity and gene pools by considering size, habitat heterogeneticy and external influences (Franklin 1977). Mexico and the U.S. have also developed a cooperative monitoring and research program. Here, joint planning and research teams have developed appropriate ecological monitoring systems and experimental studies for the Michilia Biosphere Reserve in Mexico and the Beaver Creek Watershed Biosphere Reserve in the U.S. By developing the program together from the beginning, it will be possible to share

methodology and data. We are looking forward to the development of improved forest and resource management systems from these joint studies. This pooling of international resources will enable the participants to conduct programs and share data that would not otherwise be possible. Such mutual cooperation should also reduce costs.

The MAB-8 program is not rigid in structure. The program is being directed to meet both national and regional needs. I hope that the regional forestry community would become a more active participant in the program, and thus bring their expertise to bear on problems of mutual interest.

Furthermore, I suggest that the U.S. forestry community must become better acquainted with MAB-8 activities in their region. As foresters, we have a good deal to offer the MAB program, but we have even more to gain.

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THE PARADOX OF REPEATING ERROR: YELLOWSTONE NATIONAL PARK FROM 1872 TO BIOSPHERE RESERVE AND BEYOND

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Abstract. Most of the renewable and nonrenewable resource problems that Yellowstone National Park faces today trace back to its creation over 100 years ago. When set aside in 1872, protection of geologic wonders was paramount. Forests and wildlife, two of the most important aspects of the park today, were recognized by Congress in an almost off-hand way. The boundaries they set failed to encompass a complete ecological unit. Later boundary changes attempted to remedy this, but it was too little, too late. When the park was designated a Biosphere Reserve a century later, it was again set aside for its geological wonders, which repeated and reaffirmed the earlier Congressional oversight. While the first designation did not consider the ecological integrity of the area, the second failed to consider that the greater Yellowstone region is likely the largest, essentially intact wild ecosystem remaining in the temperate zone of the earth. As a result of the development of the West, the greater Yellowstone area has become an ecological island, one which is managed by over two dozen separate political and administrative entities.

If the natural condition of this massive ecosystem is to survive in the future, an innovative new strategy for management must be devised. Supporters of the Biosphere Reserve concept seek to test and prove the concept of a model biosphere reserve as a practical management tool for the next generation. The designation of the greater Yellowstone ecosystem as a model international biosphere reserve may be the most efficient and politically acceptable way of preserving this area.

Yellowstone National Park was set aside as an International Biosphere Reserve in 1974 amid fanfare and considerable international attention. Today, some ten years later, a question might be asked as to what, if anything, the managers of the park are doing differently than they would be doing if Yellowstone was still not "just" a national park.

The answer, beyond Yellowstone's presence on prestigious lists and an impressive commemorative bronze plaque, is probably nothing, or at least very little. But why? Why would such an innovative positive concept, one which virtually all rational-thinking conservationists could embrace and rally around, be so ineffective in practice?

There are a number of answers, most of which are explored in depth by the authors of this proceedings. A pragmatic answer--one that ends as a potential solution--is offered here. Using Yellowstone as an example, a perspective with very real aspects emerges that has application to many of the designated biosphere reserves.

The Man and the Biosphere Program (MAB) selected Yellowstone National Park and recognized it for its geologic wonders. In doing so, MAB made the same error that Congress contributed to a century earlier. They failed to consider that the greater Yellowstone region was and remains the largest, essentially intact, wild ecosystem remaining in the temperate zone of the earth. Even if this were not true, the

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ecosystem is surely the only area within a nation prosperous enough to afford to prevent mass exploitation of such an extraordinarily valuable resource.

It is not our intent to demean either the park's superb geologic features, or the decisions of Congress, or MAB. What is important to consider is that Yellowstone's boundaries do not encompass a complete ecological unit, nor do they adequately protect the area's unique geothermal fields.

Despite the existence of the greatest display of wildlife in the contiguous 48 states, wildlife is one of those special resources that suffers from a lack of ecosystem integrity. While Congress at one point extended and modified the boundaries of Yellowstone Park, created additional park lands, and established national forests, in many respects it was too little, too late. The tremendous growth and development of the intermountain west has severed key connections between the Yellowstone ecosystem and the remaining Rocky Mountains. The greater Yellowstone region has become an ecological island. Development has and continues to encroach on those misplaced boundaries, with steady and cumulative results. Located in an area of northwestern Wyoming, southwestern Montana, and eastern Idaho, the greater Yellowstone ecosystem includes two national parks; a national parkway; five national forests answering to three U.S. Forest Service regions; two wildlife refuges; numerous parcels of state, corporate and private lands; and multiple town, city and county jurisdictions (Fig. 1). Resource decision-making is understandably often disjointed and does not look first to the care and maintenance of the ecosystem; the threats to its integrity are real. A recent publication by a group supporting the idea of treating the greater Yellowstone area as an ecosystem listed 88 threats to the viability of the ecosystem (Greater Yellowstone Coalition 1984).

THE IDEAL YELLOWSTONE ECOSYSTEM

A line can be drawn around the Yellowstone ecosystem which defines a unit that is both a geologic protectorate and a logical biogeographical province. This unit transcends political and jurisdictional boundaries (Fig. 2).

Because of limitations in our knowledge, however, the precise boundaries of this ecosystem must remain vague. What is clear, however, is that instead of the 2.2 million acres that make up Yellowstone National Park, the Yellowstone ecosystem is an area that may encompass over 6 million acres of wild and semi-wild lands.

Topographically, the area is comprised of nine major mountain ranges, with the vast volcanic Yellowstone plateau at the heart. Three of our nation's major river systems headwater within the unit and have helped shape and feed an amalgam of plant communities from each of the major biomes found in western North America.

The combination of a diverse plant world, varied and rugged terrain, assorted climatic effects, and the remote, often hostile nature of the location has created and even helped protect the ecosystem's varied fauna. The more well-known species found in abundance within the ecosystem are not unique to this area, though some, like the grizzly bear and trumpeter swan, are rare outside of the ecosystem. Other species, such as the elk and the bison, once reduced to meager populations, exist today in robust numbers.

But the concept of the ideal ecosystem must fall back on the original and foremost unique feature of the area. Yellowstone's geysers, hot springs, and fumeroles- -the

FIGURE 1. MAP OF THE GREATER YELLOWSTONE REGION SHOWING THE MOST PROMINENT POLITICAL JURISDICTIONS.

FIGURE 2. AN APPROXIMATION OF THE GREATER YELLOWSTONE ECOSYSTEM.

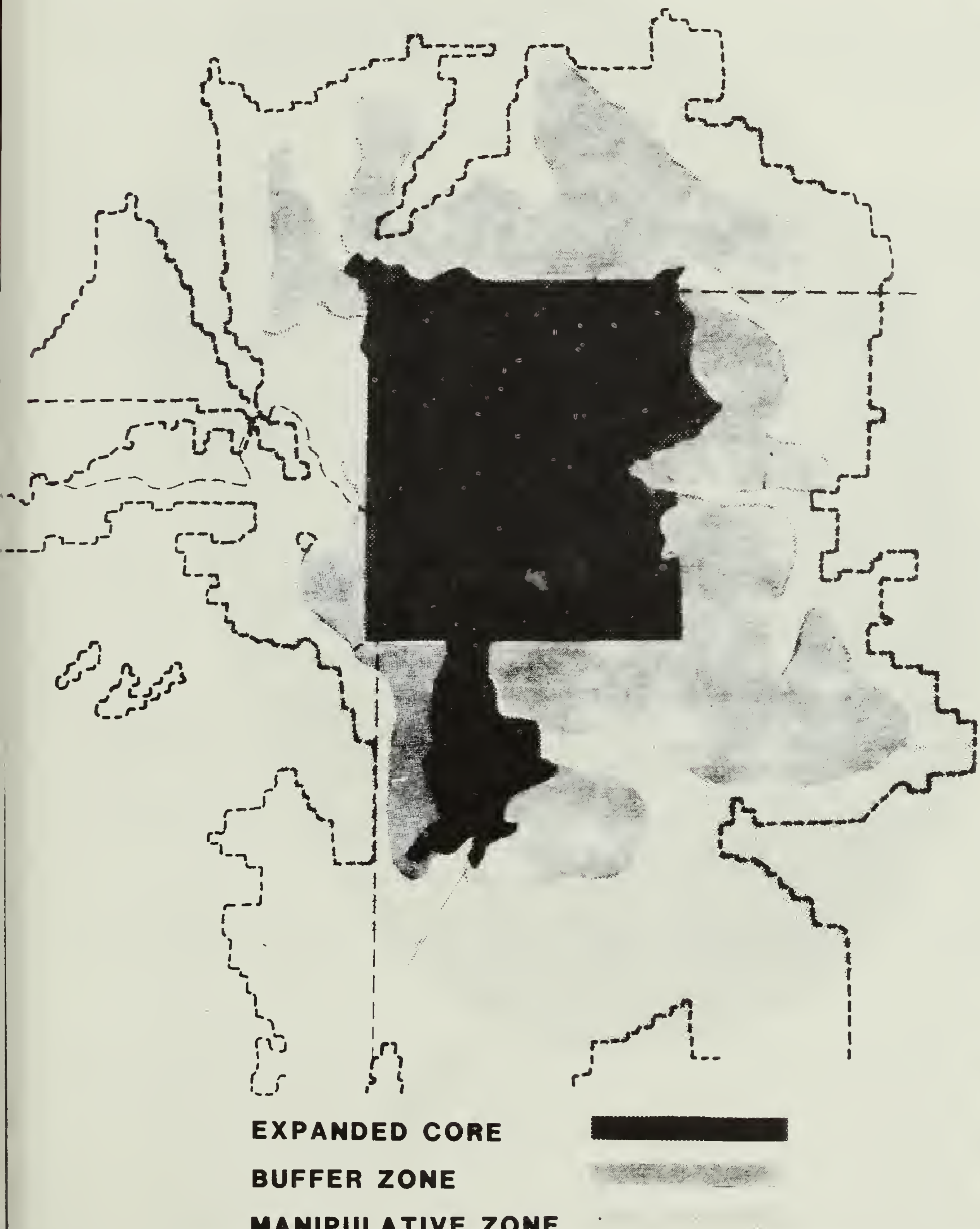

FIGURE 3. THE MODEL YELLOWSTONE ECOSYSTEM BIOSPHERE RESERVE.

greatest collection of geothermal features in the world today--illustrate the ecosystem concept best. There is mounting evidence that the aquifer feeding Yellowstone's geothermal features has its origins outside the park. This, combined with the potential exploitation of the known geothermal resource areas adjacent to Yellowstone, shows why the recognition of this ecosystem is so important.

A POTENTIAL SOLUTION

Resource managers within the ecosystem do communicate with each other and progress on that front is being made. One only needs to look at the interagency teams seeking to aid the plight of the grizzly bear, trumpeter swan, and the Jackson Hole elk herd to see hopeful signs.

Yet, if the ecological integrity of this unique area is to survive into the next century, an innovative new strategy for coordination and integrated resource management must be devised.

In this proceedings, Eidsvik thoroughly explores the past failings and the future of the Biosphere Reserve Program. He and other supporters of the concept suggest that we need to test and prove the idea of a model biosphere reserve as a practical management tool for the next generation. The model reserve would include a core natural zone, a buffer zone, and a zone of manipulation or experimentation. This concept seeks to test humanity's ability to live in harmony with its environment.

The idea of integrated management is an exciting one; one which might have the potential to work under the right circumstances, in the right place, and with the whole-hearted support of the political entities.

The greater Yellowstone ecosystem may be an ideal unit to test the model biosphere reserve. The unfragmented, oval shape of the ecosystem is, in itself, a persuasive beginning point (Fig. 3). Within it, the present Yellowstone and Grand Teton National Parks and John D. Rockefeller Parkway become the expanded core natural zone. The established and proposed wilderness areas in national forests, the Island Park Geothermal Resource Area, plus seasonal wildlife ranges become the buffer zone, and multiple-use national forest lands plus corporate and private lands become the manipulative or experimentation areas.

The most obvious advantage of this approach, beyond the fact that we have finally recognized the ecosystem as an ecosystem, is that it would probably be palatable to all of the special interests and jurisdictions. The recognition that no lands would necessarily change political or administrative jurisdiction is a decided advantage.

The managers of this nation's national parks, including Yellowstone, can no longer afford to stand by in what Eidsvik terms "splendid isolation." There is an absolute need for a mechanism to foster cooperation and integration with surrounding land managers. Improved research and monitoring efforts and land and people management are the obvious rewards. But the largest one of all would be a reasonable expectation that these ecosystems would survive into the next century.

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USE OF RENEWABLE RESOURCES--WORKSHOP SUMMARY

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The following summary was developed from the Renewable Resources Workshop led by R. Barbee and J. Franklin. This summary is divided into four sections: Concepts, Applications, Subgroup Reports, and Summary Recommendations. The Applications section makes special reference to Yellowstone National Park Biosphere Reserve, which was used in the workshop for examples of particular issues and applications. Readers should review the companion paper on Yellowstone National Park to place the following discussion in perspective. Four subgroups were organized: Reseach/Monitoring, Education/Training, Public Involvement, and Resource Management. These Subgroups met separately and then reported back to the full group. About 50 people attended the workshop and contributed to the views expressed here.

Concepts

Since U.S. national parks are legally protected from most forms of resource use (fishing being a frequent and notable exception), initial discussion centered on the following question:

> How does use of renewable resources relate to the management of biosphere reserves in general and national park biosphere reserves in particular?

We concluded that this issue represents a key component of the Biosphere Reserve Program--for the U.S. national park biosphere reserves as well as other areas. Five general reasons were discussed for the importance of this issue:

1. Core conservation areas harbor unique examples of undisturbed ecosystems. Such ecosystems are the best places to observe complex ecological relationships, the knowledge of which contributes to better management on lands where resources are used. Such ecosystems may be the best "control" systems for comparison with managed lands. Such ecosystems may essentially be early warning systems on environmental degradation, such as that caused by pollutant deposition (see elsewhere in this proceedings).

2. Core conservation areas are not islands. U.S. national parks are surrounded by lands where resources are used--such external use often affects resources within the core conservation area. Similarly, management in parks can affect or be perceived as affecting renewable resources beyond park boundaries. Further, the relationship of core conservation areas to their regional settings should not be passive--the core conservation areas have a special responsibility in a regional context. Some biosphere reserves have been set up with an explicit regional concept in mind. A larger area (e.g., a biotic province) is designated within which subareas with different land uses (core conservation areas, experimental areas, resource extraction areas, zones of cooperation) are recognized.

3. Biosphere reserves play a key role in education, training, and research-- these activities can relate specifically to resource use even when the resources are not used within the national park or core conservation area. Key training/education issues are: ecosystem integrity, sustainable resource use, improved resource utilization, and regionally appropriate management schemes.

4. Not every U.S. biosphere reserve is a national park-- other kinds of areas include experimental forests and rangelands where resource extraction is permitted and where a major focus is research on the sustained and wise use of resources. U.S. national parks are "core conservation areas," but other land use designations are encompassed within the Biosphere Reserve umbrella (see elsewhere in this proceedings).

5. Even in U.S. national park biosphere reserves, some resources are or can be treated as renewable resources: fishing is permitted in many parks, aesthetics (e.g., visibility and recreation) are usable and potentially impacted by people, and genetic diversity represents an essential resource for disease resistance traits, superior strains, and new species for use.

The following discussion summary enlarges on these five points.

The purpose of range management areas and experimental forests includes the development of appropriate management schemes for sustained, efficient use of resources. Core conservation areas have a rôle in this kind of activity--in the protection of important gene pools, in the protection of natural systems for comparison with managed ones, and the like.

Some biosphere reserves have been set up on the model of the regional biome, ecosystem, or landscape. In areas created under this model, national parks fulfill the role of the core conservation area, with other land uses also present (including private lands and lands with sustained resource extraction). Traditional agricultural landscapes are thus included in some biosphere reserves. The combination of strict preservation, resource use, and conservation planning is particularly important in the developing world.

No park is isolated from its surroundings. Parks affect renewable resources beyond their boundaries. For example, wildlife hunted beyond the park boundary may migrate regularly across that boundary. Hunting affects population characteristics observed in the park and park management influences the hunted populations outside the park. These influences may ramify through an ecosystem--different herd sizes of large herbivores lead to different grazing intensities in plant communities. The park may also harbor native species that are viewed as pests (e.g., pine bark beetles) in managed lands outside the park. Parks may be the only area that research can be done on pests and their hosts (for example, research that demonstrates the existence of genotypes resistant to the "pest").

Park wildlife populations may move out of the park-- but the boundary is not a one-way door. Air pollution, water quality impacts, and other influences permeate the park from beyond its boundaries.

There is a whole suite of park values that are very much renewable resources: visibility and other aesthetic values (of economic benefit in tourism) and genetic diversity being the two most important examples. Genetic diversity is supported by complex ecosystems that survive only in core conservation areas in terms of minimal human influence.

These resources are not often thought of as "used" or "renewable." Genetic resources have been and are being used, as when trees in core conservation areas are used for seed harvest or cuttings in the development of better genetic strains for forestry. Genetic resources represent a library which can be drawn on as needed-- and thus the use is both realized and potential. In crop plants, wild relatives may possess genes for resistance to particular diseases and pests.

Aesthetic resources are used in the sense of the tourism industry. Such resources may be impacted (as by overuse, air pollution or the encroachment of exotic species) and may be renewed by proper management.

Core conservation areas are important in the measurement of ongoing environmental degradation, such as the effects of air pollutant deposition. Such threats also affect lands beyond park boundaries where resource use is permitted.

Natural ecosystems are complex. For example, a pest organism, like a bark beetle, or a natural process, like fire, which causes heavy tree mortality, may maintain early successional patches in the landscape, thereby increasing the quantity and quality of food items for wildlife. The presence of resistant gene pools to pests may occur in such protected areas. The study of these relationships benefits our understanding of how to manage resources that are used beyond the boundaries of the core conservation areas.

<u>Applications: Yellowstone National Park Biosphere Reserve</u>

The concepts noted above apply directly to resource issues in Yellowstone National Park Biosphere Reserve. Here are examples and discussion points raised at the workshop:

1. <u>The Greater Yellowstone Ecosystem</u>. As described by R. Barbee, Yellowstone National Park is surrounded by national forest (U.S. Forest Service) lands. The park is a core conservation area within a larger landscape type.

   The park should continue its efforts to use the Greater Yellowstone Ecosystem concept as a vehicle to establish a management/research cooperative with neighboring land managers.

2. <u>Wildlife population movements</u>. Elk and bear management are two good examples of problems that depend on the recognition of the Greater Yellowstone Ecosystem. These animals move in and out of the park. Population characteristics within the park are affected by hunting outside the park boundaries. Huntable populations outside the park are affected by park management.

   Park management should use the cooperative forum to describe management goals for the core conservation area. Cooperative research should be instituted on the problem of wildlife movements and the effects of various management actions on population characteristics.

3. Lodgepole pine, pests, and fire. Lodgepole pines are affected by bark beetles. Natural fires are an important ingredient in ecosystem behavior. Fires and beetles can interact to affect fire intensity.

   The park should interpret its management philosophies to the Greater Yellowstone Ecosystem community, in terms of the importance of natural events like beetle outbreaks and fire in this ecosystem. Research should be undertaken to show the effects of these disturbances on ecosystem stability and native wildlife populations. The importance of this research to the better understanding of management of renewable resources outside park boundaries should be explicitly used in research design.

4. Genetic resources: elk, bison, and lake trout. Park gene pools have been used for the reestablishment of populations outside the park. The park should make an effort to interpret this major role to its visitors and land management neighbors.

   Comunication with neighboring land managers, interpretation of the regional focus (Greater Yellowstone Ecosystem), and joint research into the relationship of Yellowstone National Park ecosystems to park surroundings were the key recommendations in these specific areas.

Subgroup Reports

1. Research/Monitoring. Strong research programs are essential. These programs must be integrated into education and management within the biosphere reserve.

Two kinds of research are important: long-term environmental research (this is unique to the biosphere reserve mission and to protected core conservation areas in particular) and management-oriented research (to address specific research questions for better resource protection or restoration). Both of these are important with relation to renewable resources.

Long-term environmental research must be interdisciplinary. It must address ecological questions at a series of temporal and spatial scales.

Research should include both long-term research in control (core conservation) areas and experimental research. These two should be tightly linked within a biosphere reserve region.

Research is needed that will directly link preservation and resource utilization aims.

Data management is a key area for biosphere reserves. Data must be available to the scientific community. It must be archived and organized in a manner that will ensure survival.

Research should provide a means of assessing the state of health of the biosphere's natural environment. This was one of the main justifications of the Biosphere Reserve Program in the first place and is important to renewable resource use as well.

Boundary issues are a key organizing principle. Examples of research questions are migration routes of wildlife and spread of wildlife diseases. Related to this is the issue of park size: are populations included within the reserve above the critical population size needed for population persistence? What is the included species diversity and will

it be maintained within the park? All of these questions get at the basic nature of the relationship of a core conservation area to the larger regional setting.

Another important research area is landscape restoration/habitat rehabilitation. Research should be carried out on the impacts of management actions within the core conservation area (e.g., trail maintanence).

2. Education/training. Biosphere reserves do not yet have an impact in terms of interpretation. They need a strong program of image-building, using specific examples (gene pools used elsewhere, elk management in Yellowstone National Park). The idea of regional landscapes and issues needs to be used as an organizing principle.

Biosphere reserves must establish ecological training programs that will be useful to managers, from the perspective of both resource protection and land use classifications.

3. Public involvement. First, the interest groups must be identified: political institutions, managers, agencies, users, surrounding landowners, and the groups that have conflicted with management in the past.

The issues must be clarified and de-mystified. In particular, the economic benefits of biosphere reserve status must be identified.

A formal arrangement between interest groups and managers must be established--one that will survive personnel turnover.

4. Resource management. The issue of resource management with regard to renewable resources depends on the recognition that preservation areas should not dominate the biosphere reserve concept. Most biosphere reserves therefore need an expanded zone around them.

The biosphere reserve concept should be used to develop a conservation/preservation strategy for an entire biotic province. Exemplary models are needed for the integration of core conservation areas and renewable resource areas. An important aspect of this is resource planning for the future.

There is a need to develop data bases in core conservation areas and experimental areas that relate directly to resource use outside the designated areas.

The biosphere reserve concept is an important vehicle for developing a regional management concept and for interagency cooperation. Acid rain and grizzly bears are two examples of regional issues that the biosphere reserve concept should be used to bring land managers to a common forum.

Summary Recommendations

The biosphere reserve concept should be used to develop meaningful programs in research, communication, training, and interpretation.

A. Cooperative research should be used to tie core conservation areas to resource use areas (especially experimental areas) within a regional biosphere land unit. Such research can be used to demonstrate the additional values of core conservation areas (beyond the primary function of preservation).

B. A general regional conservation/preservation strategy should be used to develop communciation between managers and scientists from diverse land units within the biosphere reserve region. A regular meeting should be used to facilitate this communication.

C. Training programs on ecological science and resource management should be developed using the core conservation area.

D. Interpretation should stress the national parks as core conservation areas within larger regional settings. The value of the core conservation area to resource use issues in a larger sense should be emphasized.

MANAGEMENT OF PROBLEM SPECIES IN BIOSPHERE RESERVES

Michael A. Ruggiero[1]

Abstract. The disturbance of natural ecosystems by exotic biota or unnatural levels of native biota presents a major problem to managers of biosphere reserves. These problems are often environmental, economic, and social. An integrated approach to management- that includes monitoring, decision, action, and evaluation components-- geared to specific management objectives can provide solutions.

Keywords: Biosphere reserves, exotic species, integrated pest management.

Biosphere reserves are designated internationally to preserve and protect examples of the ecosystems of regional biomes for future generations. Batisse (1982) stated that the primary objectives of biosphere reserves are:

1. To conserve for present and future use the diversity and integrity of biotic communities of plants and animals within natural and semi-natural ecosystems, and to safeguard the genetic diversity on which their continuing evolution depends;

2. To provide areas for ecological and environmental research, including baseline studies, both within and adjacent to such reserves; and

3. To provide facilities for education and training.

Biosphere reserves should contain a core area where the natural features of the biome are protected and other areas where manipulative research and conservative uses that are not detrimental to the core area can be applied.

A major threat to the natural evolution of biotic communities in the earth's remaining natural ecosystems results from the invasion and establishment of species, directly or indirectly resulting from human activities. These species are referred to as "exotic" species. Native species may also cause problems if they are managed at unnatural levels or if natural population controls are missing. Finer distinctions have been made to include at least a third category of "naturalized" species. These species may not be native but, because of their persistence and lack of response to control efforts, they are given special status. Managers in some geographical areas have developed other categories to correspond to a particular event, e.g., the arrival of Columbus in North America or Cook in Hawaii. Exotic species that arrived before the event are treated as "native" and those arriving after the event are treated as "exotic." The major focus of this paper is on exotic species in general.

Table 1 summarizes information about the occurrence, effects, management, and research of exotic species in selected U.S. biosphere reserves The exotic plants and animals listed have been identified by reserve managers as having potential adverse effects on abiotic and biotic components of native ecosystems.

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Table 1. EXOTIC SPECIES PROBLEMS IN SELECTED U.S. BIOSPHERE RESERVES

RESERVE	EXOTIC SPECIES	AFFECTED RESOURCE	AREA	MANAGEMENT ACTIONS	PLANNED RESEARCH
Big Bend NP	tamarisk	surface water	core	monitoring, mechanical and chemical treatments	chemical, biological treatments
	livestock	riparian habitat	core	monitoring, roundups, fencing, cooperation	none
Big Thicket NP	slash pine	native flora	core	mechanical removal	none
	Chinese tallow	native flora	core	monitoring, mechanical removal	none
	hogs	soil, native flora	core	public hunting	none
Channel Islands NP	plants	native flora	core	investigate techniques	feasibility studies
	black rat	native fauna	core	trapping	none
Everglades NP	plants (ca. 100 spp.) particularly cajeput, Brazilian pepper, Australian pine	native flora	core/ buffer	monitoring, mechanical and chemical treatments	treatments
Great Smoky Mountains NP	plants (ca. 300 spp.) particularly kudzu	native flora	core/ buffer	monitoring, mechanical and chemical treatments	none
	hogs	native flora, native fauna, aesthetics	core/ buffer	monitoring, shooting, exclusion	attractants
	balsam wooly aphid	Fraser fir	core	monitoring, soap treatments	none
Olympic NP	plants (279 species)	native flora	core	monitoring, allow natural succession, investigate biological treatments	none
	mountain goat	soil, native flora	core	monitoring, live removal, cooperation	population control

Exotic species problems can be classified into four groups (modified from National Park Service, 1982):

1. Widely distributed species with high potential for damage to native biotic communities,

2. Locally distributed species with high potential for further spread or damage to native biotic communities,

3. Species with unknown potential for damage to native biotic communities, and

4. Species with little potential for damage to native biotic communities.

This or similar classifications can be used to establish priorities for addressing the total exotic species problem for a reserve. The key point is that not all exotic species are necessarily pests and not all native species are non-pests. Management objectives, such as the preservation of genetic diversity or the maintenance of natural ecosystems in biosphere reserves, are key in determining whether or not a particular species is a managed as a pest. Certain negative effects of exotic species may be more tolerable in buffer areas of a biosphere reserve than in core areas or vice versa.

The management of exotic species may be important in monetary costs. The cost related to identifying, monitoring, and removing exotic species can be quite high, but the costs of followup restoration of native species or removal of successive exotic species can be even higher. These costs make detailed planning and feasibility studies from a holistic viewpoint essential.

Exotic species can also cause problems when they disperse from biosphere reserves to neighboring lands that are managed for different objectives. Immigration of exotic species from adjacent lands into reserves is an equally important problem. Locally, managers of biosphere reserves should establish agreements with neighboring landowners to restrict the movement of exotic species across boundaries. Such agreements should protect the ecological concerns of the reserve. In the United States, Federal policies allow the eradication of exotic species when possible. Executive Order 11987 (Carter 1977) restricts executive agencies, under most conditions, from introducing exotic species into natural ecosystems of the United States or exporting native U.S. species for introduction into natural ecosystems outside the United States.

Exotic species in biosphere reserves can be managed by a strategy used in managing pest species in agricultural, urban, and other artificial ecosystems.

This strategy is called integrated pest management (IPM). It is a decision-making process that uses a systems or holistic approach to pest management. The IPM process maximizes the use of natural controls while minimizing the use of artificial treatments. Monitoring is important in predicting when injury to the system is likely so preventive actions can be taken. These actions may include preventive, mechanical, cultural, biological, chemical, sociological or other treatments that can be used individually or in combination. Systematic monitoring of the system is essential in gauging the effectiveness of the program. The key to an IPM program is to take action against those target pests approaching intolerable levels (as predicted by monitoring). The major steps in initiating the IPM approach for exotic species in biosphere reserves and sample questions to ask at each step are listed below. The questions are by no means all-inclusive; rather they are pesented as examples of the types of questions that should be asked.

1. <u>Management Objective</u>.

   - Does the species negatively affect the diversity and integrity of the natural ecosystem?

   - Must the core area be free of all exotic species?

   - Is the buffer area managed for agricultural or other ecosystem-altering purposes?

   - Is the buffer area designed to prevent the dispersal of exotics into the core area?

2. <u>Monitoring</u>.

   - What should be monitored?

   - When should monitoring occur?

   - Who should perform monitoring tasks?

   - What monitoring techniques should be used?

   - What are the major exotic species?

   - Which exotic species are problems?

   - What are the key exotic species to be managed? For example, if feral hogs are dispersing exotic plants, should the hogs be controlled before the plants?

   - Has or will the target species reach intolerable levels?

3. <u>Decision</u>.

   - What are management's priorities (e.g., largest threat to resources, greatest sociological problem, largest personnel requirement, easiest to solve, least research requirement)?

   - What population levels or damage thresholds are acceptable?

   - Is eradication of the exotic species population necessary?

   - Can the priority of the problem be changed if the existing population levels of exotic species are changed?

4. <u>Action</u>.

   - What types of treatments will be used and how will they be integrated?

   - How will treatments affect the protected ecosystems?

   - How will treatments affect nontarget, native species?

   - If it is impossible to remove the problem species, can the problem be used as an interpretive tool to teach a lesson?

5. Evaluation.

- Are management strategies working?
- Have objectives or priorities changed?
- Is the monitoring paradigm adequate?
- Are action thresholds adequate?
- Are prescribed actions acceptable?
- Should the IPM process be refined?
- Is more research needed?

The IPM approach to solving exotic species problems may appear to require considerable planning and information. For example, planning is important when attempting to manipulate populations within an ecosystem because of the inter-relationships among populations. Similarly, attempts to manipulate a single population without adequate information about the rest of the ecosystem can produce problems more serious than the original problem. Decision makers can use the IPM approach to formulate sound management programs based on limited information. New information revealed by the IPM approach in turn is accomodated by "retuning" or "fine-tuning" the existing program.

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PROBLEM SPECIES IN HAWAII VOLCANOES NATIONAL PARK BIOSPHERE RESERVE

David B. Ames[1] and Charles P. Stone[2]

Abstract. Species introduced by man in Hawaii Volcanoes National Park have adversely affected native ecosystems for over 1500 years. Early introductions by Polynesians were less important than land clearing practices, but with the arrival of Captain Cook in 1778, deterioration of native systems accelerated. Feral ungulates, introduced plants, small mammals, exotic birds and invertebrates, and alien diseases have had devastating impacts on biota that developed in isolation, often in small population units. At Hawaii Volcanoes, management and research programs are closely coordinated to reduce and eliminate feral ungulates and alien plants and to enhance native biota. Although difficult to obtain in Hawaii's political, economic and social climate, the Park is increasingly trying to improve interpretation and community outreach to increase awareness and involve other entities in preserving Hawaii's natural heritage.

INTRODUCTION

Hawaii Volcanoes National Park includes two of the most active volcanoes in the world, Mauna Loa and Kilauea. Also included are examples of Hawaiian Islands ecosystems ranging from sea level to the 13,677 ft. summit of Mauna Loa. The endemic life forms of the Hawaiian Islands, as with island systems worldwide, are seriously threatened by introduced plants and animals.

Within the 220,000 acres (89,000 hectares) of the national park are numerous historic and prehistoric features relating to human life on the slopes of the volcano over the past 1500 years. The relationships between the volcanoes, people, and the other life forms have always been complicated. In the past 200 years since the arrival of continental peoples with their various plants and animals, the situation has grown dramatically worse.

Hawaii Volcanoes National Park is unique in that volcanic research is equal in importance to the conservation and public use aspects common to other national parks. It is a primary world center for the study of volcanic hazards and related fields such as seismology. Catastrophic changes caused by volcanic eruptions, earthquakes, and tsunamis affect native biota.

It is well known that island ecosystems are fragile because they developed in isolation from few colonizers, and because "adaptive radiation" results in many small populations vulnerable to disturbance. The Hawaiian Islands are the most isolated island group in the world (Fig. 1) and are recognized as a worst case situation in terms of vulnerability to outside influences.

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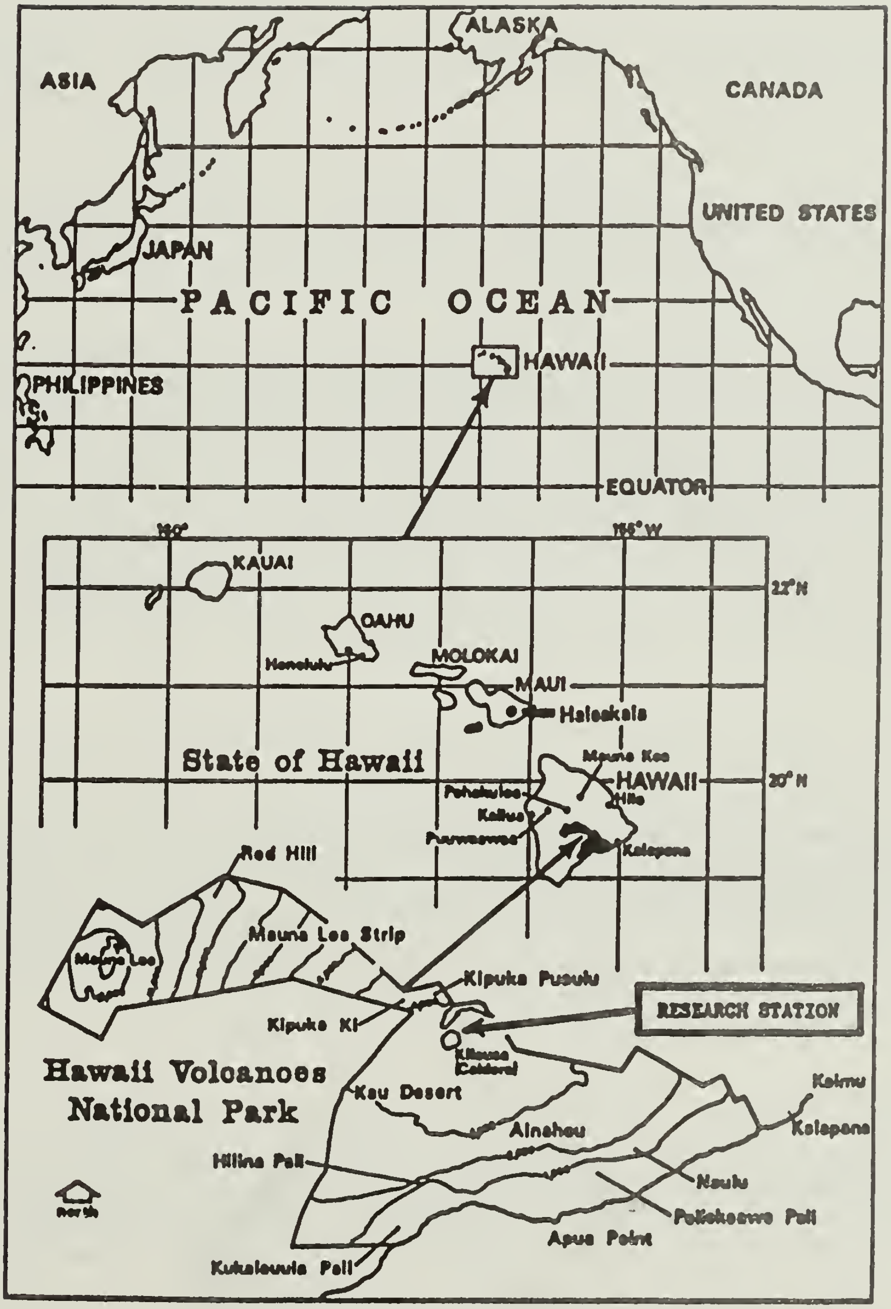


Figure 1. Location of Hawaii Volcanoes National Park in reference to the State of Hawaii and the Pacific Basin. The threats and threatened areas are universal.

The animals and plants that did arrive naturally in Hawaii came at a rate of approximately one new species each forty thousand years. These species then evolved, creating new species in adapting to the large variety of habitats found in Hawaii. These range from desert with less than 10 inches of rainfall per year, through dry forest, wet forest, and alpine life zones.

In approximately 400 A.D., the first Hawaiians arrived and brought with them various utilitarian plants and animals. Plants, such as coconut, kukui and ti, and animals such as small Polynesian pigs, dogs, and even rats, quickly became established, especially in the coastal lowlands below 2000 feet elevation. Numerous species that were already naturally rare and growing in isolated populations in the lowlands were lost, largely as a result of land clearing. Archeological and paleontological studies have only recently brought this to light. Most of the plants and animals the Polynesians brought with them were from other tropical island systems and did not aggressively invade Hawaii's native ecosystems.

After 1778 and Captain Cook's rediscovery of the Hawaiian Islands, change was greatly accelerated. In the past 200 years, 4,600 plants have been introduced into Hawaii from continental ecosystems. Six hundred have become established and 114 are considered detrimental to native Hawaiian plant life. Animals such as cattle, goats, domestic pigs, cats, dogs, mongooses, and rats were also added to Hawaiian ecosystems, which, prior to the arrival of the Polynesians, had known no land mammals other than the Hawaiian bat. Agricultural activities such as cattle ranching and sugar cane and pineapple growing, resulted in the removal of a large percentage of the remaining lowland and mid-elevation forest habitat on all major islands. Belts of forest on all the islands were fragmented by these uses. Forest isolation has had a very detrimental impact on native forest birds.

THE PROBLEM

Accidental and deliberate introductions of animals and plants have had devastating impacts that aren't fully understood, even yet. For example, it has been shown that avian malaria and avian pox, which are relatively new to the Hawaiian Islands, are transmitted by an introduced mosquito. Many native Hawaiian birds had no immunity and were quickly reduced to low population levels that were then susceptible to other impacts, such as further loss of habitat. Most bird species (about 75%) are now extinct, as a result of numerous detrimental influences, including disease.

Feral goats

The adverse effects of feral animals and alien plants are numerous and interrelated. It has been known since the establishment of the park in 1916 that goats have a disastrous impact on the park's natural systems. Feral goats at Hawaii Volcanoes have always been recognized as one of the worst natural resource problems in any national park. As late as the 1960's, goat removal was considered an unsolvable problem. However, research resulted in, and management carried out, a plan of fencing, combined with goat drives and hunting, that has eliminated the goat as a problem. In 1971, the population was estimated at 15,000 animals, but there are presently fewer than 20 goats in the park. Goat management is now a matter of maintaining the boundary fences and applying periodic hunting pressure on the remaining goats. There are so few animals left that radio-collared "Judas" goats are used to find the remaining animals so that they can be eliminated.

The effect that the goats had over 200 years was severe. They devastated Hawaiian plant species, eliminating many and creating barren situations that favored alien plants. This was especially true in the lowlands and at mid-elevations. With the removal of feral goats, countless problems involving alien plants have emerged. Aggressive continental grasses have moved in and created continuous, hazardous fire fuel situations that previously did not exist. Naturally-caused fires due to lava flows either occurred infrequently in wet forest normally too wet to burn, or in low dryland areas that were sparsely populated with native Hawaiian species too widely separated to carry fire over great distances.

Feral pigs

Feral pigs that occur in the rain forest sections of the park have been considered uncontrollable until recently, due to the difficult nature of the terrain and the widely dispersed population of approximately 4000 animals. Recent research as well as ongoing management shows, however, that once again fencing and a coordinated effort involving methods such as hunting, trapping, and snaring will be able to reduce or eliminate most of these highly destructive animals. The impact of pigs comes from rooting in the forest floor, which eliminates regeneration of native forest species and encourages alien plants in the disturbed soil. Pigs also eat rare native plants and play a role in providing breeding sites for mosquitoes that carry the avian malaria that seriously impacts forest bird species. They knock down and hollow out tree fern stumps to eat the starchy interior. This leaves stumps in the form of troughs throughout the forest to collect water in which mosquitoes breed. Standing water is extremely rare in Hawaii due to the porous nature of the rocks and soils.

Predators

Animals such as the mongoose, brought in to eliminate the rats, are devastating to such native Hawaiian bird life as the Hawaiian goose or nene. This animal, which probably resulted from the arrival some forty thousand years ago of a few Canada geese, evolved into a terrestrial bird without enemies before man's introductions. Mongooses, rats, cats and dogs, combined with a loss of habitat, have reduced the bird to near extinction. Only the combined efforts of the State of Hawaii and the national park in raising and releasing the animal are ensuring its survival. Researchers continue to study limiting factors, but the remaining habitat may be marginal.

Alien plants

Introduced plants from around the world have become established in Hawaii (Table 1). Weedy plants are favored over natives on sites disturbed by feral animals, clearings for roads, agriculture, or other human influences. Species that invade active forests aggressively are of special concern, and include banana poka, a *Passiflora*, that climbs into the canopy and smothers forests; several species of blackberry; grasses including kikuyugrass, a *Pennisetum;* and firetree, an import from the Azores that forms monotypic stands.

THE RESOURCES FOR DEALING WITH PROBLEMS

In 1984, Hawaii Volcanoes National Park had a budget of $2,318,000. Of this, $653,604 was specifically allocated to natural resource management, $157,291 to research, and $128,300 to interpretation. Of the park's 101 full- and part-time employees, 27 are employed in natural resource management, 8 in research, and 6 in interpretation. A

Table 1.--Derivation and status of Hawaiian flora and fauna and estimated extinction and endangered percentages for native taxa.

Taxa	Introduced by: Natural Processes (20,000,000 yrs)	Polynesians (2000 yrs)	Continental Man (200 yrs)	Established Species: Natives	Aliens	Estimated Percent of Natives: Extinct	Rare, Threatened, or Endangered**
Plants	272	32	4600	1400-1700	600	11	50
Terrestrial Arthropods	300-400	<100	4000+	6000	2000	50	42***
Land Mollusks	22-24	2-4	50+	1000	30	50	50+****
Land Birds*	20	1	130	35	45	75	77
Land Mammals*	1	3	21	1	18	0	100

* Not including ocean birds and mammals and migratory birds.

** Based on species listed Federally, candidates for listing, and opinions of experts.

*** Based on "index of rarity for 800 species" (Gagne, personal communication).

**** All 41 species of Achatinella (Oahu tree snails) have Federal recognition.

portion of the Park's remaining financial and personnel resources is in administrative and logistic support of these programs. Budgets and personnel are given in Table 2.

Biological research in the park is concentrated in the Hawaii Field Research Center. Housed in an old Job Corps facility, office and lab space is provided for National Park Service, U.S. Fish and Wildlife Service, U.S. Forest Service, and University of Hawaii biological researchers. The U.S. Fish and Wildlife Service's Hawaii Forest Bird Survey project is headquartered there. It has recently completed a survey of forest bird and plant life on all major islands. The U.S. Forest Service is operating a quarantine greenhouse for the study of biological controls for alien plants. This project is a cooperative effort among the National Park Service, the State of Hawaii, and the U.S. Forest Service. Park Service research focuses on feral pigs and goats, alien plants, impacts of geothermal development on forest ecosystems, restoration of the Hawaiian goose, and interrelationships of alien and exotic species in rain forest ecosystems.

The Research Center includes dormitory facilities for visiting researchers as well as groups such as university students. It provides a focus for biological research on the Big Island and the exchange of information among those involved. It also is the site of local and international conferences and seminars and a place for mainland and international visitors to stay while conducting research of value to the park.

THE INTERFACING COMMUNITY

The primary zone of influence for the Hawaii Volcanoes National Park Biosphere Reserve is, of course, the Island of Hawaii. Activities bordering the park include cattle ranching, subdivisions, logging, geothermal power plants, and a military bombing range and training area. The park, since 1971, has maintained fenced boundaries to exclude feral goats, and is in the process of fencing its remaining boundaries to exclude feral pigs.

On the Big Island of Hawaii, conservation organizations are small and not politically powerful. The same small group of individuals belongs to such groups as The Audubon Society, Sierra Club, etc. Political and community leaders are not usually included among them. The economy of the Big Island is primarily tourism and agriculture (with sugar cane and macadamia nuts major crops), and the various support services for a population of 90,000 people. The cattle industry, truck farmers, flower growers, fishermen and artists are important. Some people are involved in illegal growing of marijuana. Unemployment is high (8.9%), and the sugar cane industry is shrinking, as it has difficulty competing in the world market. Political and community leaders on the Big Island are united in an effort to improve the economic situation by attracting new business and providing more jobs. The preservation of the remaining segments of native forest is not seen as a high priority. As a typical example, a 2,200-acre section of 'ohi'a forest near the park's east boundary is being clear-cut to provide wood chips for an electrical generating plant that, prior to September 1984, burned sugar cane waste. The reason for this change is that the local sugar plantation closed.

The East Rift of the Kilauea Volcano, the upper portion of which is along the park's boundary, has the highest potential for producing electricity from geothermal energy. It is conceivable that this area could produce enough power for the entire state if it were totally and successfully developed. The upper third of this rift zone is adjacent to, and upwind of, the national park. The park and the local Volcano Community have raised concerns regarding a proposed 250-megawatt project for the past three years, resulting in the establishment of stricter controls as well as the elimination of a portion of the project along the park boundary.

Table 2.--Hawaii Volcanoes National Park Fiscal Year 1984 personnel and budget.

Activity	Personnel	Budget
Administration, Maintenance, and Protection	60	$ 1,378,740
Interpretation	6	128,300
Resource Management	27	653,604
Research	8	157,291
Subtotal, NPS	101*	2,317,935
CPSU, University of Hawaii	2	91,000
U.S. Fish and Wildlife Service	10	623,000
U.S. Forest Service	2	114,000

* The Park has a total allotment of 59.8 FTE. Several positions shown are part-time or contracted.

Whenever possible, exhibits and other interpretive media emphasize the effects of problem species. Newspaper and magazine articles, ranging from the local paper to Audubon magazine, tell the story to a broad audience. A new exhibit in front of the visitor center highlights feral pigs and their management and is attracting much attention.

The recent designation of the park as a biosphere reserve has had the effect of adding emphasis to the value of the resources. We use this designation both in interpretive messages and for additional justification of resource protection.

THE CHALLENGE

Damage from introduced animals and plants is the primary natural resource problem facing Hawaii Volcanoes National Park. The same could be said for other publicly- and privately-owned large tracts of land throughout Hawaii. If Hawaii Volcanoes National Park and the Biosphere Reserve of which it is a part are to continue to preserve natural processes and species assemblages, a cooperative education, research, and management effort must be aggressively pursued. Community education and outreach, cooperative efforts and communication with other agencies and organizations and media, and close relationships with legislators and other leaders are essential. (We think that the groundwork for this has been established though such cooperative efforts as the Hawaii Field Research Center.) We need to increase our efforts to ensure the survival of the increasingly important examples of unique Hawaiian ecosystems provided in Hawaii Volcanoes National Park.

The objective of this workshop is to analyze this case study and apply biosphere reserve concepts in ways that reflect the multiple roles of biosphere reserves in research, resource management, interpretation and cooperative activities at the local, regional and worldwide levels.

PROBLEM SPECIES WORKSHOP SUMMARY

David B. Ames
Hawaii Volcanoes National Park

The workshop on Problem Species came up with two primary areas for biosphere reserve managers to emphasize-- education and research.

Educating the public about biosphere reserve concepts as well as resources contained in core areas is of paramount importance. Teacher workshops to spread the information to school children are an effective means of reaching a large and growing population. Interpretation within core areas such as national parks should stress the biosphere reserve concepts such as the interrelationships among managers of protected areas, developers, and the public interest and the importance of reserves in furthering knowledge for the benefit of all. If there are several core areas within a biosphere system (e.g., state parks and reserves and national parks), the interpretive programs should be coordinated and linked so that visitors can draw comparisons among all areas. Interpretation about linked development programs and more intensively used adjacent lands and zones of cooperation is also worthwhile.

Science conferences based on current research with biosphere reserves formalize and coordinate an exchange of information. They allow professional scientists, educators, developers, conservationists, and others to keep up-to-date and have input. Open exchange during resource management planning meetings also serves this function. The popular media and legislators need to be informed about resource values. This spreads the message about resource values and allows decision-makers to make more informed choices when conflicting land uses are proposed.

Research and resource management activities in biosphere reserves need to emphasize the ecosystem approach rather than the preservation of individual species. The boundaries of ecosystems need to be clearly defined and well known. Long-term monitoring and careful recordkeeping that will be of use in future decisions is mandatory. Monitoring cycles need to be established, programs funded, and the responsibility for monitoring clearly defined. Without proper continual baseline monitoring of vegetation, for example, it is difficult to make decisions about priorities for controlling feral ungulates.

Some research can be conducted outside core areas that will serve as demonstrations for state or private action in the future. An example would be feral animal exclosures on state forest land or on a private ranch that would clearly demonstrate benefits to natural ecosystems.

Problem species need to be clearly defined as to the exact problems they cause and control priorities established. Species are sometimes considered problems when they merely are aliens that may not be important. Control of more significant problem species should be carefully evaluated in terms of effects of control methods on ecosystems, long-term commitments of human resources, other priorities, and tolerable levels of problem species in different situations. Research has a key role here, as does careful trial and error management. When both can work together, avoiding early generalizations and widespread untested control programs, and serving to demonstrate results to others, the biosphere reserve concepts as applied to problem species can be especially valuable.

Agencies with different specialists and abilities need to work cooperatively because funds, expertise, manpower, and time are limited. In Hawaii, the search for biological control for noxious plants is being carried out by a U.S. Forest Service entomologist in a National Park Service quarantine facility supported by field research conducted by State of Hawaii entomologists in foreign countries. This example of cooperative research, management, and education by those with much to gain, economically or ecologically, from reducing problem species impacts over large regions is a fine example of biosphere reserve ideas in practice.

APPENDIX

February 1985

UNITED NATIONS EDUCATIONAL,
SCIENTIFIC AND CULTURAL ORGANIZATION

PROGRAMME ON MAN AND THE BIOSPHERE
(M A B)

ACTION PLAN FOR BIOSPHERE RESERVES

Summary

On the basis of the results of the First International Biosphere Reserve Congress, jointly convened in Minsk in 1983 by Unesco and UNEP in cooperation with FAO and IUCN, at the invitation of the USSR, and of consultations with conservation specialists and scientists which have since taken place, an Action Plan for Biosphere Reserves was adopted by the International Coordinating Council of the Programme on Man and the Biosphere at its eighth session (Paris, 3-8 December 1984) and is presented in this document as a programme framework. This framework identifies a range of actions for consideration by governments and concerned international organisations in developing the multiple functions of biosphere reserves within the overall context of the MAB Programme. Those actions concretely serve the implementation of the World Conservation Strategy. While a number of actions are of a permanent nature, the stress is placed on activities which can be carried out in the period 1985-1989.

In summary, governments and international organisations are invited to undertake activities which will improve and expand the international biosphere reserve network, to develop basic knowledge for conserving ecosystems and biological diversity, and to make biosphere reserves more effective in linking conservation and development in fulfilling the broad objectives of MAB.

Although each government has its own priorities, from an international perspective, there is a minimum set of activities which should be implemented in each biosphere reserve and for which international organisations should provide support as appropriate. These are: baseline inventories of flora and fauna and their uses; monitoring; preparation of a history of research; establishment of research facilities and research programmes; establishment of training and education programmes; and preparation of a management plan which addresses biosphere reserve functions. The approved Action Plan, together with an indication of financing requirements, will be submitted in due course for consideration by the Governing organs of UNEP, Unesco, FAO and IUCN.

(SC-85/WS/26)

INTRODUCTION

1. The Man and the Biosphere (MAB) Programme, launched in 1971, is a world-wide programme of international scientific cooperation dealing with people-environment interactions in the whole range of bioclimatic and geographic situations of the biosphere - from polar to tropical zones, from islands and coastal areas to high mountain regions, from sparsely populated regions to dense human settlements. Research under the MAB Programme is designed to provide the information needed to solve practical problems of resource management. It also aims to fill the still significant gaps in the understanding of the structure and function of ecosystems, and of the impact of different types of human intervention. Key ingredients in the MAB Programme are the involvement of decision makers and local people in research projects, training and demonstration in the field and the pooling of disciplines from the social, biological and physical sciences in addressing complex environmental problems.

2. The International Coordinating Council which supervises the MAB Programme, at its first session in 1971, decided that one of the themes of this programme was to be the 'conservation of natural areas and the genetic material they contain'. Under this theme was introduced the concept of the biosphere reserve which was intended to be a series of protected areas, linked through a coordinated international network, which would demonstrate the value of conservation and its relationship with development. The concept was innovative because of this network character and because it combined nature conservation with scientific research, environmental monitoring, training, demonstration, environmental education and local participation.

3. Since the very beginning of the implementation of the concept of biosphere reserves as representative ecological areas, the international biosphere reserve network has formed a geographic focus for implementing the MAB Programme.

4. The first biosphere reserves were designated in 1976. Subsequently, the network has grown steadily until 1984; at present, it consists of a total of 243 in 65 countries. In this same period, ccoperation with other international organizations involved with conservation and sustainable development has been strengthened, particularly the Food and Agriculture Organisation (FAO), the United Nations Environment Programme (UNEP) and the International Union for Conservation of Nature and Natural Resources (IUCN). Representatives of these four organizations meet together regularly through the Ecosystem Conservation Group to coordinate action.

5. FAO has a major interest in biosphere reserves because of their contribution to the _in situ_ conservation of genetic resources, especially wild crop relatives, forest species, and ancestors and close relatives of domestic livestock. UNEP is promoting the value of the international network for conservation in general, and in particular, for environmental monitoring using comparable methodologies and parameters. IUCN considers that biosphere reserves constitute a useful concept for regional planning in which conservation is linked directly with sustainable development, in line with the World Conservation Strategy.

6. It was therefore in the joint interests of FAO, UNEP, IUCN and Unesco that the First International Biosphere Reserve Congress was convened in 1983 to review the experience of the past ten years and to establish a general framework to guide the future development of the biosphere reserve network.

THE CHARACTERISTICS OF BIOSPHERE RESERVES

7. The main characteristics of biosphere reserves are:

(a) Biosphere reserves are protected areas of representative terrestrial and coastal environments which have been internationally recognised for their value in conservation and in providing the scientific knowledge, skills and human values to support sustainable development.

(b) Biosphere reserves are united to form a worldwide network which facilitates sharing of information relevant to the conservation and management of natural and managed ecosystems.

(c) Each biosphere reserve includes representative examples of natural or minimally disturbed ecosystems (core areas) within each of the world's biogeographical provinces; and as many of the following types of areas as possible:

   (i) centres of endemism and of genetic richness or unique natural features of exceptional scientific interest (which may be part or all of the core area);

   (ii) areas suitable for experimental manipulation to develop, assess and demonstrate the methods for sustainable development;

   (iii) examples of harmonious landscapes resulting from traditional patterns of land use;

   (iv) examples of modified or degraded ecosystems that are suitable for restoration to natural or near-natural conditions.

   Collectively, the various types of above areas provide the framework for carrying out the scientific and management functions of biosphere reserves.

(d) Each biosphere reserve should be large enough to be an effective conservation unit, and have value as a benchmark for measurements of long-term changes in the biosphere.

(e) Biosphere reserves should provide opportunities for ecological research, education, demonstration and training;

(f) The "buffer zone" may consist of any one or some combination of (ii) to (iv) of (c) above, which are areas suitable or used for research purposes. In addition, the "buffer zone" may also include a large

area which may be undelineated but where efforts are made to develop cooperative activities which ensure that uses are managed in a manner compatible with the conservation and research functions of the other areas of the reserve cited in (c) above. This multiple-use area may contain a variety of agricultural activities, settlements and other uses and may vary in space and time, thus forming an "area of cooperation" or "zone of influence".

(g) Biosphere reserves must have adequate long-term legislative, regulatory or institutional protection. Biosphere reserves may coincide with, or incorporate, existing or proposed protected areas, such as national parks or protected research sites. This is because some of these protected areas are often the best examples of the natural unaltered landscape or because they constitute suitable areas for carrying out the various functions of biosphere reserves.

(h) People should be considered as part of a biosphere reserve. People constitute an essential component of the landscape and their activities are fundamental for its long-term conservation and compatible use. People and their activities are not excluded from a biosphere reserve; rather they are encouraged to participate in its management and this ensures a stronger social acceptance of conservation activities.

(i) Normally, there is no need for changes in land holding or regulation following the designation of a biosphere reserve except where changes are required to ensure the strict protection of the core area or of specific research sites.

8. The above characteristics however may give an insufficient impression of the breadth of the concept. Successful biosphere reserves constitute models of the harmonious marriage of conservation and development. They provide visible examples of the application of the World Conservation Strategy - sustainable development in action.

FUNCTIONS OF BIOSPHERE RESERVES

Conservation as an open system

9. Although it has long been clear that the whole variety of organisms and ecosystems cannot be safeguarded satisfactorily for ever if their sole refuges are protected areas of the more conventional types, this is the only approach that has been applied widely in practice so far. If genetic conservation is to be successful in weathering natural and man-induced environmental change, a more open system of conservation is required, in which areas of undisturbed natural ecosystems can be surrounded by areas of sympathetic and compatible use. The biosphere reserve provides these conditions. It should, perhaps, be looked upon less as a 'reserve' than as an area of ecologically representative landscape in which land-use is controlled, but may range from complete protection to intensive, yet sustainable, production. Under certain circumstances these areas need not even be contiguous but separate from one another ("cluster concept" of

biosphere reserves). This arrangement of graded control allows for a flexibility of treatment that is necessary if conservation is to be assured under changing circumstances.

10. Because they contain a substantial proportion of the indigenous flora and fauna of a biogeographic region, biosphere reserves are important reservoirs of genetic material. These resources increasingly are finding application in developing new pharmaceuticals, industrial chemicals, building materials, food sources, pest control agents, and other products to improve human well-being. The genetic resources of biosphere reserves also may provide genetic material for reestablishing indigenous species in areas where they have been eradicated, thereby enhancing the stability and diversity of regional ecosystems. Within particular natural regions, biosphere reserves are linked to form local and regional networks with other types of protected areas which safeguard complementary ecosystems and elements of biological diversity.

11. A unique aspect of biosphere reserves is the conservation, where practicable, of traditional land use systems, illustrating harmonious relationships between indigenous populations and the environment. These systems often reflect centuries of human experience and can provide information of immense value in improving the productivity and sustainability of modern land use and management practices. In addition to providing important sites for scientific study, the inclusion of such areas can help to foster pride on the part of local populations in their traditions; and to provide the basis for improving their means of livelihood, through the judicious use of science and technology, in ways which respect these traditions.

Research and monitoring function

12. Because of their secure protection, generally large size, and the inclusion of areas free from significant human impact, biosphere reserves typically provide ideal sites for monitoring changes in the physical and biological components of the biosphere. Their protection and scientific mission make biosphere reserves particularly attractive sites for gathering scientific information. Scientists can have more confidence than in most other areas that the integrity of study sites will be respected, and that collected data will contribute to a growing data bank of increasing scientific significance. As land use changes and human impacts progressively decrease the availability of suitable monitoring sites, scientific interest in biosphere reserves will increase.

13. In most protected areas, research is a secondary function which is intended to provide information to enable effective response to immediate resource management problems within the protected areas themselves. In biosphere reserves, interdisciplinary research programmes involving the natural and social sciences are encouraged to develop models for sustainable conservation of the ecosystems of a large natural region. Biosphere reserves provide sites for coordinated research, including research to determine requirements for conserving biological diversity, to assess the impacts of pollution on the structure and functions of ecosystems, to evaluate the effects of traditional and modern land use practices on ecosystem processes, and to develop sustainable production systems for degraded areas.

14. Additionally, the international network provides a framework for comparative studies of similar problems in different parts of the world; for testing, standardizing and transferring new methodologies; and for coordinating the development of information management systems.

The education and training function

15. Biosphere reserves can serve as important field centres for the education and training of scientists, resource managers, protected area administrators, visitors, and local people. The strong emphasis on developing educational and training programmes within biosphere reserves is probably unique. The nature of these programmes depends on the particular conditions, capabilities, and needs of the biosphere reserve and the surrounding region. However, the following kinds of activities are generally encouraged:

- academic and professional training;
- environmental education;
- demonstration and extension;
- training for local people supplemented by the provision of employment opportunities.

The cooperation function

16. Cooperation not only serves as the master integrator of the other functions, but also provides the moral force behind the biosphere reserve concept. Biosphere reserve status can provide a framework for improving cooperation at the local, regional, and international level. Cooperation is increasingly regarded as an aspect of good management for all categories of protected areas. However, biosphere reserves are distinguished from other categories of protected areas in several ways as follows.

17. First, cooperation has been embodied, specifically and visibly, in the biosphere reserve concept from its inception. Unlike other protected areas, it is an essential part of the symbolism, and a key factor in fostering personal commitment on the part of growing numbers of people.

18. Second, cooperation at the local and regional levels is broadly based, involving diverse interests and people with different perspectives. Efforts are directed towards finding practical and sustainable strategies for dealing with complex and interrelated environmental, land use, and socio-economic problems affecting a particular biogeographic region. For this reason, the range of interests involved in planning and implementing the biosphere reserve concept typically includes biosphere reserve administrators, natural and social scientists, resource managers, environmental and development interests, government decision-makers and local people. Communication between these groups is based on the need to integrate conservation and development within the biogeographic region, and on the recognition of the value of a biosphere reserve. Through these cooperative efforts, an area around the biosphere reserve can eventually be developed, which represents a zone of influence in which cooperative activities and harmonious land uses can be implemented. The spatial dimensions of this area expand as more participants cooperate in building the biosphere reserve. Developing the network of cooperation for carrying out the mission of the biosphere reserve is an open-ended process.

19. Biosphere reserves can also provide the catalyst for establishing appropriate mechanisms to marshall the professional capabilities of government agencies and academic institutions to provide a perspective on the ecosystem use and management problems of particular regions.

20. Finally, all biosphere reserves are part of the international network, which provides a framework for communication within and among biogeographic regions. Cooperation involves the sharing of technology and information, and the development of coordinated monitoring and research projects, to provide better information on problems of common interest. Biosphere reserves are particularly suitable for cooperative monitoring of regional and global pollutants and their effects on natural and managed ecosystems, for cooperative ecosystem modelling, for assessment and forecasting, and in comparative assessment of alternative systems for managing renewable resources. Cooperation may also involve the exchange and training of specialists to assist in selecting biosphere reserves and developing their functions.

THE ACTION PLAN

21. There are three main thrusts in the programme framework of the action plan, all designed to promote and implement the concept of the biosphere reserve and to make it a more effective agent for sustainable development. These are: improving and expanding the network; using the network to increase knowledge; and making biosphere reserves more effective in demonstrating the value of integrating conservation and development.

Improving and expanding the network

22. One of the principal objectives of the Action Plan is to improve and expand the world coverage of biosphere reserves by including:

- representative ecological areas within each of the world's biogeographical regions, in their natural state and as modified by man to varying degrees,

- centres of endemism and of genetic richness; and

- areas for carrying the full range of biosphere reserve functions.

Developing basic knowledge for conserving ecosystems and biological diversity

23. A number of actions are concerned with generating and disseminating useful knowledge, in particular:

- using biosphere reserves for background global monitoring of chosen biological, chemical and physical variables;

- carrying out research in basic ecological processes, which can be applied in management, and in 'conservation science';

- monitoring the results and effectiveness of management;

- assembling traditional knowledge about the use of species and ecosystems; and,

- spreading all such knowledge by example, publication, wide dissemination in various other forms, training, exchange of staff and of local people and by setting up demonstration biosphere reserves to illustrate these matters to a wide public.

Making biosphere reserves more effective in linking conservation and development

24. Existing and new biosphere reserves are to be made more effective in various ways:

- ensuring that biosphere reserves meet the criteria and serve the purposes intended for them, and are not just other sorts of protected areas given another name;

- guaranteeing their protection by legislation and/or management;

- linking goals of conservation and development;

- improving the effectiveness of management and monitoring the standards of management;

- incorporating in present and future management the traditional skills of those who live in and around biosphere reserves; and

- ensuring the understanding and participation of local people who are affected by the biosphere reserves.

25. Although it is expected that biosphere reserves will be established and maintained on a permanent basis, the Action Plan concentrates on recommendations for action during the period 1985 to 1989, which coincides with the United Nations Systems Wide Medium-Term Environment Programme as well as the medium-term plans of several of the sponsoring organisations. It is designed to be both realistic and practical. Some actions will be initiated or undertaken by UN organisations (in particular Unesco, UNEP, FAO, WHO and WMO) and by IUCN. Due consideration will be given to appropriate requirements of the World Conservation Strategy and other relevant action plans such as the UN Plan to Combat Desertification. However, most actions will be a matter for individual countries to implement in accordance with their own priorities. Success, therefore, will largely depend on the support of governments - in their domestic policies, in the attitudes they take in the Governing bodies of international organisations and in asking for and giving technical assistance.

26. This Action Plan presents a set of recommended actions which governments and international organisations can implement to better fulfill the functions of biosphere reserves. Given a reasonable level of funding and international support, substantial progress can be made in implementing most of these recommendations by 1989. It is proposed that a meeting be held to review the progress made and draw up directions for future actions in 1990.

27. Every government establishes its own priorities for implementing activities in biosphere reserves. These activities all contribute to the worldwide network to the extent that their results are shared among the cooperating nations. However, from an international perspective, there is a minimum set of activities which should be implemented in each biosphere reserve. These include:

- Baseline inventories of species of fauna and flora and their present and traditional uses (to provide the basis for further research, monitoring, and information activities).

- Establishment of procedure for monitoring key biological parameters.

- Preparation of a history of research, which specifies what research has been carried out and includes a complete bibliography of relevant publications, as well as an analysis of the relationship with other ongoing pilot projects, and especially national or international projects of the MAB Programme.

- Establishment of research facilities and a research programme which outlines the research activities envisaged for the following five years or so.

- Establishment of a training/education programme appropriate for local needs and conditions.

- Preparation of a management plan which specifies the steps to be taken in developing biosphere reserve functions (this may often involve only minor alterations to existing management plans).

OBJECTIVES AND ACTIONS

OBJECTIVE 1. INTERNATIONAL NETWORK: TO ENHANCE THE ROLE OF THE INTERNATIONAL NETWORK OF BIOSPHERE RESERVES IN GLOBAL ECOSYSTEM CONSERVATION

28. In spite of vigorous action during the past decade to make governments aware of the importance of biosphere reserves and to promote their establishment, there are still many gaps and deficiencies in the network.

* Many important representative types of ecosystem are still to be included, especially of coastal and aquatic ecosystems.

* Only a few biosphere reserves established so far cover the full range of purposes for which biosphere reserves were intended.

* Few reserves have been established, which include centres of high biological diversity and endemism, particularly the centres of concentration of the wild relatives of economically important plants and animals.

* The significance of the biosphere reserve concept and the added importance of having a network are not fully appreciated, so a number of countries have not yet responded, and others have proposed areas that only partially profit from the advantages offered by this concept of land use.

29. This is an important objective; because, without a full network, many of the other objectives can only be partially satisfied. Action on it is, therefore, crucial. Promotion of the philosophy of the biosphere reserve and strengthening the network are, of course, tasks that will never be fully complete; but it should be possible by 1990 to lay firm groundwork for subsequent continuing action.

Recommended actions

Action 1. In order to provide the basis for a rational selection of biosphere reserves that would give a complete biogeographical cover, **IUCN**, in cooperation with **UNEP**, should prepare and publish:

* A classification of 'representative ecological areas' on land; and

* A classification of 'representative ecological areas' covering intertidal and marine habitats in coastal areas.

Action 2. In order to move rapidly and systematically in expanding the network of biosphere reserves, **Unesco, UNEP, FAO and IUCN** should coordinate their planned activities and develop a phased programme to identify gaps in ecosystem representation and biosphere reserve functions, and to stimulate action based on these evaluations. The results of these evaluations should be widely publicised.

Action 3. **Governments** should be urged to take such action as appropriate to fill the identified gaps in ecosystem representation and biosphere reserve functions. In this they are encouraged to consult and cooperate with the governments of neighbouring countries to develop a coherent and coordinated approach. **Governments** should also develop basic information for refining and accelerating the selection of biosphere reserves, and should take full advantage of recent advances in remote-sensing.

Action 4. In order to take the first steps in establishing a series of biosphere reserves covering the main areas of specific and genetic diversity, **FAO and IUCN** should develop a survey of centres of endemism, and of centres of concentration of wild relatives of economic species, starting with a pilot project for one biogeographic realm and for a few selected groups of organisms. Following completion of the pilot project, **Unesco, UNEP, FAO and IUCN** should, if appropriate, develop a programme for extending the project to other parts of the world and to other groups.

Action 5. In order to make the network of aquatic and wetland biosphere reserves more complete and effective, **IUCN** should convene a working group to examine the special managerial, legislative and institutional problems related to such reserves and develop necessary guidelines for their solution.

Action 6. **Unesco** should immediately establish a Biosphere Reserve Scientific Advisory Panel to refine criteria for the selection and management of biosphere reserves, to evaluate proposals for new biosphere reserves and to review from time to time the effectiveness of the network.

OBJECTIVE 2. MANAGEMENT: TO IMPROVE AND UPGRADE THE MANAGEMENT OF EXISTING AND NEW BIOSPHERE RESERVES TO CORRESPOND WITH THEIR MULTI-PURPOSE OBJECTIVES

30. The long-term security of the biosphere reserve should be assured through legal instruments, regulations or a management framework directly applicable to the biosphere reserve or to its separate management units and land ownerships. In many countries, the legal and administrative protection normally afforded to national parks, ecological research areas and other protected areas is adequate for the protection of biosphere reserves. Where such legal and administrative protection does not exist, it should be developed especially for the area concerned before it is nominated as a biosphere reserve.

31. In the land surrounding the core area and the research sites, the objective is to encourage uses and activities which do not adversely affect the conservation and research functions of the biosphere reserve. Protection in these areas may involve laws or regulations to promote land uses which are compatible with the biosphere reserve. However, the buffer zones and surrounding areas frequently are multiple-use areas in which compatible uses depend on voluntary cooperation to protect the biosphere reserve. A wide range of situations, involving various combinations of legal instruments, administrative regulations, and voluntary cooperation are possible depending on the particular ecological, socio-economic, cultural and institutional context of the reserve. In the particular case of marine habitats in coastal areas, special provision should be made so that the adjacent littoral and the catchment basins of its drainage system are adequately protected.

Recommended actions

Action 7. To ensure an adequate basis for protection and management of biosphere reserves, governments and responsible administrators are encouraged to review legal instruments relating to biosphere reserve units and to pursue revisions where needed.

Action 8. In order to assess the adequacy of existing laws and to help design new legislation, where appropriate, **IUCN in cooperation with FAO** should collect and synthesize information on the managerial requirements of biosphere reserves, on the legislative measures used by governments to secure these, and on the institutional arrangements which can be adopted for the satisfactory administration and management of biosphere reserves. **FAO, IUCN** and **Unesco** should make this information available on request and prepare and publish guidelines on the subject.

Action 9. To improve the effectiveness of biosphere reserves in carrying out their multiple functions, **MAB National Committees** should be asked to review the management of existing biosphere reserves, develop management guidelines, and recommend implementing measures to improve the standard of management appropriate to the legal, administrative, ecological, cultural and socio-economic conditions affecting the reserves.

Action 10. In order to assist in the task of bringing the management of biosphere reserves up to the highest possible standard, **FAO and IUCN, in cooperation with UNEP and Unesco,** should assist biosphere reserve administrators to develop model management plans for up to four biosphere reserves chosen to cover a range of different purposes, and should distribute these extensively..

Action 11. **Unesco, in cooperation with UNEP, FAO and IUCN,** should continue to provide missions to governments to advise on selection, establishment, legislation and management of national systems of biosphere reserves, and on the setting up and management of such reserves. Biosphere reserves should be recommended as an integral part of any National Conservation Strategy.

OBJECTIVE 3. IN SITU CONSERVATION: TO PROMOTE THE CONSERVATION OF KEY SPECIES AND ECOSYSTEMS IN BIOSPHERE RESERVES

32. There are great differences between species in their requirements for space and in the size of population that is genetically viable and would preserve its full genetic potential. These considerations are very significant in the choice of biosphere reserves (their size, shape and internal heterogeneity) and in their management; in general the smaller and more uniform the reserve, the more intervention likely to be required. Special problems are associated with wide-ranging vertebrates, especially predatory mammals and birds, and with migratory species. These are fields in which more research is needed and in which new knowledge and experience is constantly accumulating.

33. Closer collaboration and a greater exchange of information is needed between those dealing with the *in situ* and the *ex situ* conservation of the same groups of organisms.

Recommended actions

Action 12. In order to ensure the conservation *in situ* of key species and ecosystems, **governments** should be asked to take specific and urgent measures in relation to particular species and ecosystems of great importance or under particular threat.

Action 13. In order to illustrate the principles and methods of *in situ* conservation of wild relatives of economically important species, pilot projects should be initiated by **FAO, in cooperation with UNEP,** to demonstrate management techniques allowing their conservation in existing or potential biosphere reserves.

Action 14. **FAO, in cooperation with Unesco,** should set up mechanisms for the exchange of information between those biosphere reserves providing for the *in situ* conservation of selected groups of organisms and those institutions dealing with the *ex situ* conservation of the same groups.

OBJECTIVE 4. RESEARCH: TO PROMOTE COORDINATED RESEARCH PROJECTS ON CONSERVATION SCIENCE AND ECOLOGY WITHIN BIOSPHERE RESERVES

34. The development of the research function of biosphere reserves commands the highest priority. Biosphere reserves provide securely protected sites for carrying out long-term basic and applied research programmes to develop the scientific basis for the sustainable use and the long-term conservation of these natural and managed ecosystems, in conformity with the objectives of the MAB Programme.

35. The data obtained from long-term research programmes in biosphere reserves are particularly valuable for the development of models to enable the prediction of environmental changes and trends, and their possible effects on human society.

36. Of particular importance is the role of biosphere reserves in providing an international framework for comparative research, between natural and managed ecosystems within a given biosphere reserve or between separate biosphere reserves in the network which either have analogous ecological characteristics or similar ecological problems. MAB research undertaken within the biosphere reserve network can be linked, to great mutual advantage, to other international research programmes.

Recommended actions

Action 15. In order to develop the research potential of the biosphere reserve network, **governments** should be encouraged to set up cooperative, bilateral or multilateral pilot projects involving:

a) basic and applied research;

b) comparative research involving managed and natural ecosystems;

c) comparative research involving biosphere reserves with analogous ecological characteristics or similar ecological problems;

d) application of new technologies (e.g. remote sensing or modelling) in such research; and

e) development and expansion of north-south, south-south, and north-north linkages for research and educational purposes.

Action 16. Unesco should try to marshall resources from other institutions to assist governments to conduct research in selected biosphere reserves on the priority research topics identified under the MAB Programme (such as on tropical mountains, soil biological processes, succession and regeneration, multipurpose plants, restoration of degraded ecosystems, etc.) in order to strengthen the cohesiveness of the Programme.

Action 17. Unesco, in cooperation with FAO, WHO and IUCN, should develop and maintain a register of plant and animal taxa occuring in biosphere reserves. This register should include basic information on the ecology,

distribution and status of these taxa, paying due attention to those of potential agricultural or medical interest. In addition, **Unesco,** in cooperation with these same organisations, should organise the systematic collection and storage of information on the uses (traditional and modern) of these taxa and should build up a data bank and an information service to synthesize and disseminate this information.

Action 18. Unesco, in cooperation with UNEP, should review the development of the science relating to the conservation of biological diversity and should publish a review of the 'state of the art' and recommendations for action.

Action 19. Unesco should try to marshall the resources from other institutions to assist governments to conduct research in conservation science relating to biosphere reserves, with emphasis on studies to guide the design of protected areas and the management of genetic resources.

Action 20. In order to show how development may be based on local knowledge, **Unesco, in cooperation with UNEP,** should assist governments to initiate pilot projects to demonstrate how knowledge of traditional uses may be combined with modern scientific work to allow rational, sustainable use of local resources.

Action 21. In order to promote the restoration of degraded ecosystems, **Unesco** should encourage governments to support research in this field and should develop a mechanism for the exchange and dissemination of information about relevant successful experiences in biosphere reserves.

OBJECTIVE 5. MONITORING: TO DEVELOP MONITORING ACTIVITIES IN BIOSPHERE RESERVES IN ORDER TO PROVIDE A BASIS FOR SCIENTIFIC RESEARCH AND MANAGEMENT ACTIVITIES AND CONTRIBUTE TO THE UNDERSTANDING OF ENVIRONMENTAL CHANGE

37. Because of their scientific objectives and protective status, many biosphere reserves are of particular value for the long-term monitoring of global biogeochemical cycles, ecological processes, and the effects of human use on the biosphere (particularly as sites for monitoring background levels of pollutants). Fully and properly used, they can make a great contribution to global monitoring and can provide ground truth data for remote sensing and other purposes. In this, close collaboration is needed with UNEP (GEMS programme), WMO (World Climate Programme), FAO and other organisations.

Recommended actions

Action 22. In order to maximise the contribution of biosphere reserves to international environmental monitoring programmes, **UNEP (GEMS) and Unesco** should encourage governments to make biosphere reserves available for global environmental monitoring programmes. **UNEP in collaboration with FAO, WHO, WMO, ICSU** and other interested organisations should:

a) identify those parameters of global scientific significance that can be easily and inexpensively monitored on a long-term basis, and design appropriate monitoring programmes;

b) develop standardised, reliable, and widely applicable methods for collecting and comparing data and assuring quality control;

c) select biosphere reserves which are suitable for this work and promote the use of these sites with the governments concerned; and

d) seek support for the monitoring of abiotic and biotic parameters of different ecosystem components (eg. litter, soil, atmosphere, water, etc.) in biosphere reserves, including biological indicators of environmental change.

Action 23. In order to increase its contribution towards the integrated monitoring of the biosphere, **WMO** should further develop any methodologies and instrumentation necessary for the monitoring of the atmospheric component and initiate collection and analysis of the relevant data. **WMO** should also, as far as possible and appropriate, use biosphere reserves for background monitoring of the atmosphere and for long-term monitoring of climate.

OBJECTIVE 6. REGIONAL PLANNING: TO ENHANCE THE ROLE OF BIOSPHERE RESERVES IN REGIONAL PLANNING AND DEVELOPMENT

38. Integrated rural development projects which strengthen the functions of biosphere reserve are a means for ensuring the success of the biosphere reserve concept. One of the most valuable features of biosphere reserves is that they offer an excellent way of integrating conservation with development - by building on the knowledge of indigenous peoples about the sustainable management of their ecosystems and about the properties and values of the plants and animals therein. When this is appropriately supplemented by modern science and technology, such knowledge should enable even better use to be made of those ecosystems while preserving their essential character and to do this in ways that benefit local peoples and are acceptable to them. Such measures will also serve to safeguard the primitive cultivars of economic crops. This path of development is especially suitable in many areas of the developing world but could also be followed with advantage in some of the less favoured rural areas of developed countries.

39. This path may take a number of forms, for example:

* increasing the productivity of locally adapted systems of farming, in ways that retain the richness of the local flora and fauna and the protective character of the vegetation.

* developing, around core areas that should be strictly protected as genetic reserves, patterns of more productive yet sustainable land use that are of benefit to local people and are acceptable to them.

* linking biosphere reserves to major development projects to ensure that these contain appropriate elements of protection and of the sustainable use of local ecosystems.

40. Biosphere reserves, by definition and intent, have economic and social benefits for local people, but also have value in demonstrating sustainable development tied to conservation in the wider biogeographical region. While biosphere reserves have those inherent benefits, they need to be publicised. Biosphere reserves provide a framework demonstrating the economic benefits which can result from the protection of natural and managed ecosystems.

Recommended actions

Action 24. To demonstrate the value of biosphere reserves in integrated regional planning, **governments** should develop existing biosphere reserves as models of balanced and sustainable development. These models should be used to demonstrate the economic and social benefits of conservation. Where biosphere reserves have not yet been established, **governments** should set up such areas, and also consider nominating for biosphere reserve designation successful projects which integrate conservation (involving a protected area) and rural development, or projects which have such potential.

Action 25. In order to ensure that large development projects contain the requisite elements of conservation, the **World Bank, and other international and regional development-financing organisations** should ensure that any development project financed by them should not affect the basic functions of existing biosphere reserves. These organisations should support the establishment of biosphere reserves as a compensatory measure to mitigate the adverse ecological effects of the development project, financed by them that would affect major ecosystems. They should also consider support for rural development projects involving biosphere reserves which will help to develop the full range of biosphere reserve functions.

OBJECTIVE 7. LOCAL PARTICIPATION: TO PROMOTE LOCAL PARTICIPATION IN THE MANAGEMENT OF BIOSPHERE RESERVES

41. For biosphere reserves to be successful, it is essential that they be locally acceptable. This is not always easy for a number of reasons. There may be conflict between the requirements of short-term economic pursuits and conservation: there may be different local views on land use; and the local and national interests may diverge. Careful consultation and planning are necessary, as well as a continual dialogue involving tact, understanding and imagination.

42. Moreover, the situation is seldom stable. Growing populations, changing expectations, improved technology or communications, and economic pressures from outside may change the whole pattern of land use and local perceptions of priorities. The biosphere reserve should be able to evolve in harmony with all these changes and enable local populations to adjust to demographic and economic transitions without environmental deterioration.

Recommended actions

Action 26. In order to obtain the commitment of people who live in or adjacent to biosphere reserves, **governments** should ensure that these people are encouraged to participate in planning for the management of the area. Where possible, they should also participate in the scientific research, monitoring, and other activities taking place in the reserve. Furthermore, **governments** should encourage the setting up of mechanisms for consultation so that conflicts may be resolved and changing local perceptions may be reflected in the management of the reserve.

Action 27. **Unesco**, in cooperation with governments, should develop pilot projects in biosphere reserves to demonstrate the successful involvement of local people, and should arrange for the transfer of staff, knowledge and skills among such projects.

Action 28. **Unesco**, in cooperation with governments, should collect and disseminate information about successful arrangements for consultation and participation. **Unesco** should in particular encourage studies on the mechanism of participation of institutions and local people in the development of biosphere reserve functions under different social, economic and cultural conditions.

OBJECTIVE 8. ENVIRONMENTAL EDUCATION AND TRAINING: TO PROMOTE ENVIRONMENTAL EDUCATION AND TRAINING RELATED TO BIOSPHERE RESERVES AND TO USE THE FULL POTENTIAL OF THE RESERVES FOR THESE PURPOSES

43. Biosphere reserves play a valuable role in environmental education and in the training of specialists and practitioners. They can introduce local people to the idea that protecting natural areas and sustainable development are to their benefit. Local people could also be made aware of the wider national and international significance of the areas in which they live. Biosphere reserves could also be used much more in educating various sectors of the public in these same things.

44. The network would also provide ideal conditions for training resource managers and research workers. Because of the special features of the network, there are exceptional opportunities for sharing experience of working in comparable ecosystems and analogous conditions in other parts of the world, and for developing special relations in international training between pairs or groups of institutions with shared problems or interests.

Recommended actions

Action 29. Unesco should assist governments to strengthen the environmental education function of biosphere reserves, and to provide facilities which will heighten the awareness of local people and visitors on environmental matters.

Action 30. **Unesco** should assist governments to include conservation as a subject in the curricula of training institutions, with particular

reference to the role of the biosphere reserve concept and network, and to use their biosphere reserves for field training of specialists in ecology and life sciences, as well as of future biosphere reserve managers.

OBJECTIVE 9. INFORMATION: TO USE FULLY THE POTENTIAL OF THE NETWORK TO GENERATE AND SPREAD KNOWLEDGE ABOUT THE CONSERVATION AND MANAGEMENT OF THE BIOSPHERE AND TO PROMOTE THE BIOSPHERE RESERVE CONCEPT THROUGH INFORMATION AND DEMONSTRATION

45. An important purpose of the biosphere reserve network is the generation and dissemination of knowledge. This concept of an information network, in particular, distinguishes biosphere reserves from other protected areas. The full potential of this aspect of the biosphere reserve network should be developed.

46. It is important that the information from biosphere reserves be published in scientific literature, in the form of guidelines and handbooks and be presented as attractive and persuasive materials for various sectors of the public. Personal contact is also very important. The exchange of people among biosphere reserves can play a vital role in enabling the sharing of skills and experience.

Recommended actions

Action 31. Unesco, in cooperation with UNEP and IUCN, should prepare and distribute attractive brochures and audio-visual material which would explain the characteristics and functions of biosphere reserve networks to a wide audience.

Action 32. To develop the biosphere reserve information system, **Unesco** should:

a) determine a suitable structure for a decentralised system for collection, storage, synthesis, evaluation and dissemination of information associated with biosphere reserves;

b) define the various potential users and beneficiaries of the particular kinds of information;

c) establish mechanisms that ensure that this information reaches the intended users.

Action 33. Governments should be asked to contribute to the biosphere reserve information system by providing the following types of information:

a) publications and audio-visual material relating directly to the biosphere reserve concept;

b) basic information on the geographical, biological (including species' lists), and social characteristics of each biosphere reserve;

c) bibliography of scientific literature relating to individual biosphere reserves;

d) legislative and administrative provisions for biosphere reserves;

e) the details of management plans;

f) history of relevant research and monitoring.

Action 34. **Unesco** should use already existing information systems to disseminate scientific bibliographies and data relating to biosphere reserves.

Action 35. **Unesco** should encourage governments to develop model biosphere reserves which demonstrate to the international scientific community, to national and local leaders, and to politicians and decision makers the usefulness and international importance of biosphere reserves for conservation, science and society.

TABLE: Timeframe, Relative Priorities and Status of the Actions Recommended in the Action Plan for Biosphere Reserves

—— Main effort
- - - Continuing activity

ACTIONS	SYNOPSIS	1985	1986	1987	1988	1989	Cooperating entities	Priority	Status (x= ongoing)
No.									
INTERNATIONAL NETWORK									
1	Classification of "representative ecological areas"	——	——				IUCN,UNEP	1	X
2	Identification of gaps in ecosystem representation and biosphere reserve functions	——	——	——	——	——	Unesco, UNEP, FAO and IUCN	1	X
3	Filling gaps in ecosystem representation and biosphere reserve functions	——	——	——	——	——	Govts	1	-
4	Survey of centres of endemism		——	- - -	- - -	- - -	FAO, IUCN, Unesco, UNEP	1	-
5	Management, legislative and institutional problems of wetland biosphere reserves		——				IUCN	1	-
6	Establish a Biosphere Reserve Scientific Advisory Panel	——	- - -	- - -	- - -	- - -	Unesco	1	-
MANAGEMENT									
7	Review legal instruments on biosphere reserves	——	——	- - -	- - -	- - -	Govts.	2	-
8	Collection, synthesis and dissemination of information on legislative measures		——	——	- - -	- - -	IUCN, FAO, Unesco	2	-
9	Review biosphere reserve management and develop management guidelines	——	——	- - -	- - -	- - -	Govts.	1	-
10	Develop model management plans and pilot projects	- - -	——	——	——	——	FAO, IUCN, UNEP, Unesco	2	-
11	Missions to advise govts. on selection, establishment, legislation and management of biosphere reserves	——	——	——	——	——	Unesco, UNEP, FAO, and IUCN	1	X
IN SITU CONSERVATION									
12	Special and urgent protection of species and ecosystems under threat	- - -	- - -	——	——	——	Govts.	1	X
13	In situ conservation of wild relatives	——	——	——	——	——	FAO, UNEP	1	-
14	Mechanisms for information exchange between in situ biosphere reserves and ex situ institutions	——	——	- - -	- - -	- - -	FAO, Unesco	2	-

ACTIONS	SYNOPSIS	1985	1986	1987	1988	1989	Cooperating entities	Priority	Status
N°.									
RESEARCH									
15	Develop research potential of biosphere reserves						Govts.	1	-
16	Marshall resources for priority MAB research						Unesco	2	-
17	Register of plant and animal taxa in biosphere reserves						Unesco, FAO, WHO and IUCN	1	X
18	Prepare "state-of-the-art review" on conservation science with recommendations for action						Unesco, UNEP	1	-
19	Marshall resources to conduct research on conservation science in biosphere reserves						Unesco	2	-
20	Initiate pilot projects on traditional uses combined with modern science							2	-
21							Unesco, UNEP		
21	Support research and information exchange on restoration of degraded ecosystems						Unesco	2	X
MONITORING									
22	Identify parameters of global scientific significance						UNEP, Unesco, FAO WHO, WMO, ICSU	1	X
23	Use of biosphere reserves for atmospheric monitoring and long term monitoring of climate						WMO	1	X
REGIONAL PLANNING									
24	Develop model biosphere reserves to demonstrate value in integrated regional planning						Govts.	1	X
25	Involve biosphere reserves in development projects						World Bank, Development financing organisations	1	X

ACTIONS	SYNOPSIS	1985	1986	1987	1988	1989	Cooperating entities	Priority	Status
No.									
LOCAL PARTICIPATION									
26	Ensure local involvement in biosphere reserve						Govts.	1	X
27	Develop pilot projects based upon principles of local involvement						Unesco	2	-
28	Disseminate information and study mechanisms for the participation of local people in biosphere reserves						Unesco	1	X
EDUCATION AND TRAINING									
29	Strengthen environmental education function in biosphere reserves						Unesco	1	X
30	Promote conservation in curricula and use of biosphere reserves in field training						Unesco	2	-
INFORMATION									
31	Prepare and distribute promotional material on biosphere reserves						Unesco, UNEP, IUCN	1	-
32	Develop decentralised information system on biosphere reserves						Unesco	2	-
33	Governments to contribute to this information system						Govts.	1	X
34	Use existing information systems to disseminate biosphere reserve data						Unesco	2	-
35	Develop model biosphere reserves in range of ecological and socio-economic context						Unesco	1	X

MAB'S ORGANIZATION

International Coordinating Council for MAB
35 participating MAB nations
Sets MAB objectives and international priorities
Coordinates MAB with United Nations and nongovernmental organizations

Advisory Panel on MAB
Oversees MAB Program
Advises ICC on program directions

Advisory Panel on Biosphere Reserves
Oversees biosphere reserve project
Recommends approval of BR nominations

MAB Bureau
6 representatives from ICC
Provides MAB program guidance to Secretariat

UNESCO MAB Secretariat (Paris)
12-member professional staff
MAB administrative support
Endorses/funds international projects

National Committees for MAB
104 nations have national committees
Sets national policy and priorities
Coordinates agency/institutional participation
Approves biosphere reserve nominations

MAB Project Directorates
Interdisciplinary membership
Plan and implement projects
Recommend nominations of biosphere reserves (MAB-8)

MAB Secretariat*
Administers MAB budget
Provides information and coordination
Supports Directorate projects

14 possible subject areas:

MAB-1: Tropical Forests
MAB-2: Deciduous Forests
MAB-3: Grazing Lands
MAB-4: Arid Lands
MAB-5: Coastal and Fresh Water
MAB-6: Mountains and Tundra
MAB-7: Islands
MAB-8: Biosphere Reserves
MAB-9: Pesticides
MAB-10: Engineering Works
MAB-11: Urban Ecosystems
MAB-12: Demography
MAB-13: Human Perception of Environmental Quality
MAB-14: Pollution

* In the U. S., the MAB Secretariat, located at the Department of State, administers MAB through funds and personnel provided by State and other participating Federal agencies.

LANDMARKS IN THE HISTORY OF MAB'S BIOSPHERE RESERVES PROJECT

1972: UNESCO launches Biosphere Reserves Project as part of MAB.

1974: UNESCO publishes biosphere reserve selection guidelines. Nixon-Brezhnev Summit Communique calls for U.S. and U.S.S.R. to establish biosphere reserves. Several countries (including U.S.) announce establishment of first biosphere reserves.

1975: UNESCO publishes world map of biogeogeographic provinces for use in selecting biosphere reserves. UNESCO issues official designation procedures.

1976: UNESCO officially designates the first biosphere reserves.

1981: UNESCO's "Ecology in Action" conference and exhibit commemorates tenth anniversary of MAB, and includes review of Biosphere Reserves Project.

1983: First International Congress on Biosphere Reserves (Minsk, Byelorussian, U. S.S.R.) recommends Action Plan for Biosphere Reserves.

1984: First regional conference on the management of biosphere reserves convened in the United States. International Coordinating Council approves Action Plan for Biosphere Reserves and establishes Scientific Advisory Panel on Biosphere Reserves.

STATISTICS ON THE INTERNATIONAL NETWORK OF BIOSPHERE RESERVES
(as of January 1985)

Number of sites: 243

Number of countries: 65

Number of biogeographical provinces represented: *95 ex 193

Largest biosphere reserve: Northeast Greenland National Park (Denmark), 70,000,000 ha.

Smallest biosphere reserve: Miramare Marine Park (Italy), 60 ha.

Largest national networks (number of biosphere reserves):

United States: 41	Bulgaria: 17	U.S.S.R.: 14
United Kingdom: 13	Australia: 12	Iran: 9

Biosphere reserves in developed countries: 157 (65%)

Biosphere reserves in developing countries: 86 (35%)

Participation of administrators in the United States

National Park Service:	22 administrative units
Forest Service:	15 units
State agencies:	6 units
The Nature Conservancy:	3 units
Agricultural Research Service:	3 units
Universities:	3 units
U.S. Fish and Wildlife Service:	1 unit
Miscellaneous:	1 unit

*estimate. Actual figure considering biosphere designations in 1984 has not been made available by UNESCO.

PROCEDURE FOR DESIGNATION OF BIOSPHERE RESERVES IN THE U.S.

MAB interdisciplinary panel recommends most qualified sites in a particular natural region.

↓

MAB Project Directorate on Biosphere Reserves reviews panel report and recommends sites for nomination.

↓

MAB Secretariat (State Department) obtains written concurrence of site administrator.

↓

MAB Secretariat (acting for U.S. National MAB Committee) sends nomination to Advisory Panel on Biosphere Reserves.

↓

MAB Advisory Panel recommends approval of nomination by MAB Bureau.

↓

MAB Bureau approves nomination (the site officially becomes a biosphere reserve at this time).

↓

Director General of UNESCO signs designation certificate.

↓

UNESCO MAB Secretariat (Paris) sends designation certificate to U.S. MAB Secretariat for transmittal to site administrator.

↓

Site administrator holds dedication ceremony (optional).

SOME WAYS MAB CAN ASSIST BIOSPHERE RESERVES

Provide a symbolic and a political framework for improving cooperation at the local, region and international levels.

Identify opportunities for cooperative activities.

Provide a catalyst, through endorsement and/or limited funding, for activities satisfying MAB objectives, such as:

--Workshops and conferences to provide perspectives and strategies for dealing with major domestic/international environmental policy issues.

--Interdisciplinary research involving the natural and social sciences, or interdisciplinary synthesis of existing information.

--Comparative research involving core and experimental research areas.

--New areas of study for expanding the basis for conserving biosphere reserves (e.g., genetics of natural populations, design of protected areas, ethnobiology).

--Establishing and maintaining long-term ecological monitoring programs.

--Developing information systems (e.g., MAB Conservation Data Base of regional and national-level maps in digital format).

--Maintaining professional associations among biosphere reserves in different countries to encourage coordinated research and management on problems of common interest.

--Building programs and institutions to foster local and regional cooperation for better management.

--Developing demonstration and training programs to support the mission of biosphere reserves.

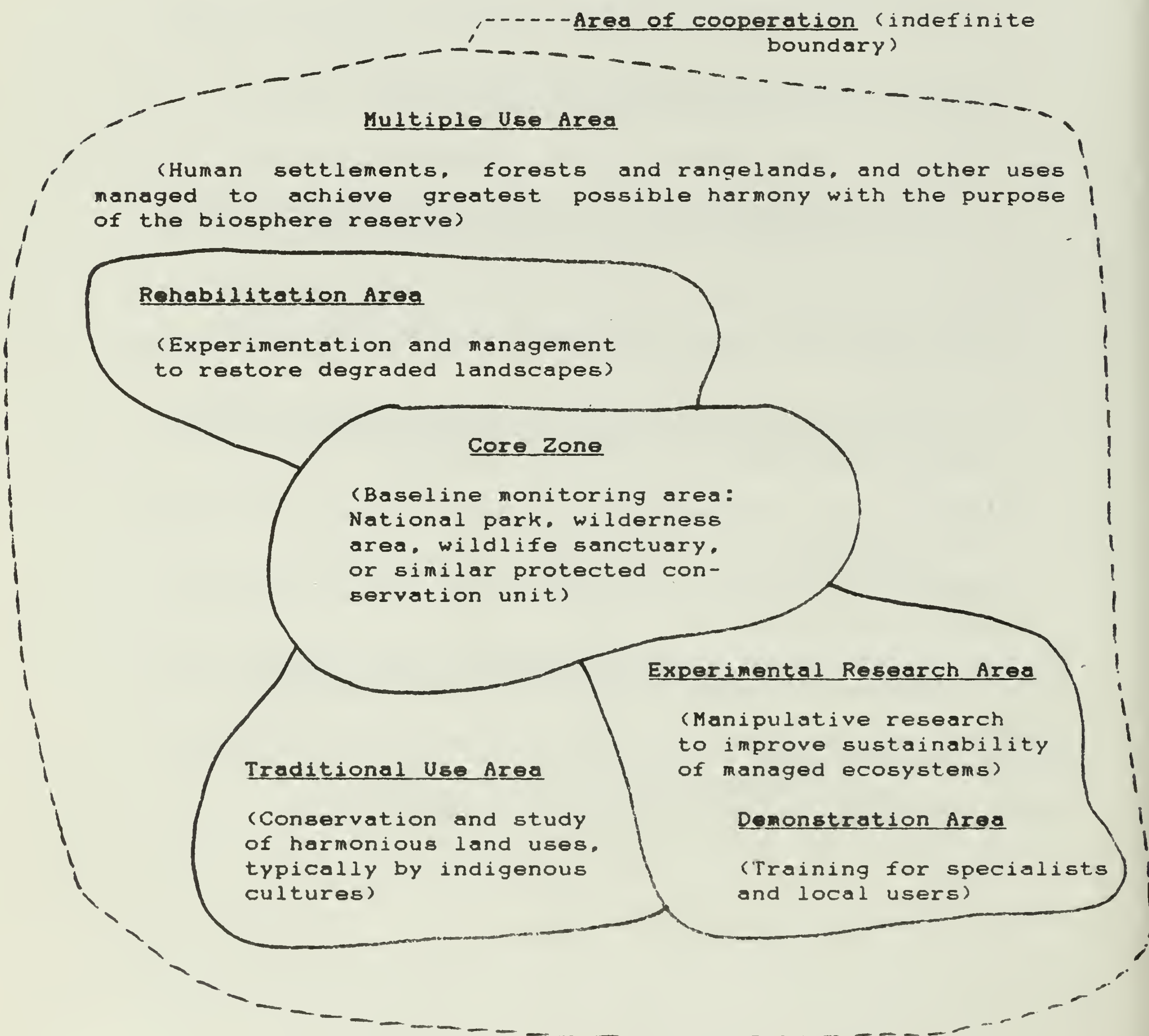
Provide an aegis for communicating with the public on the role of protected areas in developing harmonious relationships between people and their environment.

Provide interdisciplinary professional comment on projects having potential adverse effects on biosphere reserves.

Assist and participate in dedication ceremonies for biosphere reserves.

THE IDEAL BIOSPHERE RESERVE

The ideal biosphere reserve conserves all of the representative ecosystems of a particular natural region. It contains the greatest possible diversity of physical and biological resources. It carries out a wide range of research, education, training, and demonstration activities in contiguous or nearby areas. Together, these activities provide the knowledge and skills needed to conserve biological diversity while enabling the ecosystems to be managed on a sustainable basis for a wide range of amenities and commodities.



ACTIONS YOU CAN TAKE TO IMPLEMENT THE BIOSPHERE RESERVE CONCEPT: SOME SUGGESTIONS

Recognition

Recognize it on the entrance sign(s)

Recognize it on the letterhead

Recognize it in news releases and brochures

Display the designation certificate

Display the bronze plaque

Cite it as a keyword for journal articles

Name your research station for the biosphere reserve

Designate a "man and the biosphere" day or week for special biosphere reserve programs and events

Hold a dedication ceremony

Science

Establish sites for long-term monitoring

"Pair" with another biosphere reserve domestically or internationally

Establish a biosphere reserve research station

Provide temporary lodging for visiting scientists

Prepare a comprehensive history of scientific activities, including a machine-readable bibliography

Encourage interdisciplinary collaboration (especially involving the natural and social sciences)

Establish cooperative agreements with regional universities to encourage scientific use

Participate in national and international monitoring networks (e.g., National Atmospheric Deposition Program, UNEP's Global Environmental Monitoring Systems, MAB's Northern Science Network)

Adopt standard protocols for monitoring (to ensure consistency, accuracy, and comparability of data)

Submit a long-term ecological research proposal to the National Science Foundation

Develop a BR library, photo archive, and strategic collections program

Encourage studies on genetic resource conservation

Facilitate research through logistical support and cooperative attitude

Publish an annual research newsletter

Public Education

Publish on your biosphere reserve "model" in popular and professional publications (MAB could establish a BR journal)

Require scientists and resource managers to publish popular articles on BR projects

Establish a multi-institutional regional interpretative center

Develop an outreach program on BR issues, with emphasis on the regional school system

Give seminars on BR in regional universities

Interpret the role of protected areas in addressing regional and global environmental issues

Interpret relationships between people and environment

Interpret MAB program and multiple roles of BR

Display MAB's "Ecology in Action" exhibit

Display/adapt MAB's biological diversity exhibit

Develop special media to demonstrate the role of your BR in the region

Offer BR slide-tape show, an exhibit, and/or brochures to visitors

Begin or contribute to an environmental column in your local newspaper

Distribute BR brochure

Training

Incorporate BR into agency training program

Develop orientation programs tailored to the interests of special constituencies

Develop a biosphere reserve orientation and training program

Hold regional/international workshop on a key ecosystem management issue

Encourage use of BR for student training

Demonstrate land management methods to local/regional landowners

Implement a BR orientation program for local people

Natural Resource Management

Develop cooperative programs/projects for managing selected communities/species

Develop a regional geographic information system

Establish the core area (s) and the area (s) of cooperation (over the years, this may involve adding sites under different administrators)

Involve local people in setting objectives and planning

Implement programs to reestablish regionally extirpated species

Program and Operations

Hire local people

Establish special performance standards for BR scientists, resource management specialists, interpreters, and administrators

Identify BR activities in your programs

Adopt consistent "generic" objectives for BR areas

Prepare a BR plan or incorporate BR into normal planning procedure

Allocate funds for MAB activities in BR budget

Establish a line-item for BR activities in agency programs

Encourage private sector support, such as through a student research fellowship for research on biological diversity

Cooperation

Support staff involvement in collaboration with overseas BR colleagues for short-term and long-term projects

Establish a regional research/resource management cooperative

Establish a BR coordination group with neighboring landowners

Establish a BR coordination group with native peoples

Reconvene BR administrators and specialists on a regular basis

Implement neighborhood projects to assist in resource management, research, or maintenance of the BR, while building local understanding and support

LIST OF BIOSPHERE RESERVES
LISTE DES RESERVES DE LA BIOSPHERE

Name of Area	Biogeographical Code	Area (ha)	Year
ALLEMAGNE, REPUBLIQUE FEDERALE D'			
Voir paragraphe Germany, Federal Republic of			
ARGENTINA/ARGENTINE			
Reserva de la Biosfera "San Guillermo"	8.37.12	981,660	1980
Reserva Natural de Vida Silvestre "Laguna Blanca"	8.36.12	981,620	1982
Parque Costero del Sur	8.31.11	30,000	1984
AUSTRALIA/AUSTRALIE			
The Unnamed Conservation Park of South Australia	6.10.07	2,132,000	1977
Prince Regent River Nature Reserve	6.03.04	633,825	1977
Kosciusko National Park	6.06.06	625,525	1977
Southwest National Park	6.02.02	403,240	1977
Danggali Conservation Park	6.10.07	253,230	1976
Fitzgerald River National Park	6.04.06	242,727	1977
Uluru (Ayers Rock-Mount Olga) National Park	6.09.07	132,550	1977
Croajingolong	6.06.06	101,000	1977
Yathong Nature Reserve	6.13.11	87,698	1977
Hattah-Kulkyne NP & Murray-Kulkyne Park	6.13.11	49,550	1977
Wilson's Promontory National Park	6.06.06	49,000	1981
Macquarie Island Nature Reserve	7.04.09	12,785	1977
AUSTRIA/AUTRICHE			
Neusiedler See-Osterreichischer Teil	2.12.05	25,000	1977
Gurgler Kamm	2.32.12	1,500	1977
Lobau Reserve	2.32.12	1,000	1977
Gossenkollesee	2.32.12	100	1977
BIELORUSSIE REPUBLIQUE SOCIALISTE SOVIETIQUE			
Voir paragraphe Byelorussian Soviet Socialist Republic			
BOLIVIA/BOLIVIE			
Reserva Biologica de Ulla Ulla	8.36.12	200,000	1977
Parque Nacional Pilon-Lagas	8.06.01	100,000	1977
BULGARIA/BULGARIE			
Parc national Steneto	2.33.12	1,865	1977
Reserve Djendema	2.33.12	1,775	1977
Reserve Maritchini ezera	2.33.12	1,510	1977
Reserve Parangalitza	2.33.12	1,509	1977
Reserve Baevi doupki	2.33.12	1,449	1977
Reserve Boatine	2.33.12	1,228	1977
Reserve Doupkata	2.33.12	1,210	1977
Reserve Koupena	2.33.12	962	1977
Reserve Bistrichko Branichte	2.33.12	943	1977
Reserve Tchouprene	2.33.12	936	1977
Reserve Tsaritchina	2.33.12	616	1977
Reserve Srebarna	2.11.05	600	1977
Reserve Mantaritza	2.33.12	576	1977
Reserve Ouzounbodjak	2.33.12	575	1977
Reserve Tchervenata stena	2.33.12	571	1977

Reserve Kamtchia	2.33.12	556	1977
Reserve Alibotouch	2.33.12	530	1977
BYELORUSSIAN SOVIET SOCIALIST REPUBLIC			
Berezinsky Reserve	2.11.05	76,201	1978
CAMEROON, UNITED REPUBLIC OF			
Reserve forestiere et de faune du Dja	3.02.01	500,000	1981
Parc national de la Benoue	3.04.04	180,000	1981
Parc national de Waza	3.04.04	170,000	1979
CANADA			
Waterton Lakes National Park	1.19.12	52,597	1979
Mont St Hilaire	1.05.05	5,550	1978
CENTRAL AFRICAN REPUBLIC			
Bamingui-Bangoran Conservation Area	3.04.04	1,622,000	1979
Basse-Lobaye Forest	3.02.01	18,200	1977
CHILE/CHILI			
Laguna San Rafael NP (including El Guayaneco NP)	8.11.02	1,742,000	1979
Parque Nacional Lauca	8.36.12	520,000	1981
Torres del Paine National Park	8.37.12	163,000	1978
Reserva de la Biosfera 'Araucarias'	8.22.05	81,000	1983
La Campana-Penuelas	8.23.06	19,095	1984
Parque Nacional Juan Fernandez	5.04.13	18,300	1977
Parque Nacional Fray Jorge/Reserva Nacional Las Chinchillas	8.23.06	14,074	1977
CHINA/CHINE			
Changbai Nature Reserve	2.14.05	217,235	1979
Wolung Nature Reserve	2.01.02	207,210	1979
Dinghu Nature Reserve	4.06.01	1,200	1979
COLOMBIA/COLOMBIE			
El Tuparro Nature Reserve	8.27.10	928,125	1979
Cinturon Andino Cluster Biosphere Reserve	8.33.12	855,000	1979
Sierra Nevada de Santa Marta (incl. Tayrona NP)	8.17.04	731,250	1979
CONGO			
Parc national d'Odzala	3.02.01	110,000	1977
COSTA RICA			
Reserva de la Biosfera de la Amistad	8.16.04	500,000	1982
COTE D'IVOIRE			
Voir paragraphe Ivory Coast			
CUBA			
Sierra del Rosario	8.39.13	10,000	1984
CZECHOSLOVAKIA			
Trebon Basin Reserve	2.32.12	70,000	1977
Krivoklatsko Reserve	2.32.12	62,792	1977
Slovak Karst Reserve	2.11.05	36,100	1977
DENMARK/DANEMARK			
Northeast Greenland National Park	1.17.09	70,000,000	1977

ECUADOR			
Archipiélago de Colon (Galapagos)	8.44.13	766,514	1984
EGYPT/EGYPTE			
Omayed Experimental Research Area	2.18.07	1,000	1981
EQUATEUR			
Voir paragraphe Ecuador			
ESPAGNE			
Voir paragraphe Spain			
ETATS-UNIS D AMERIQUE			
Voir paragraphe United States of America			
FRANCE			
Réserve de la biosphère du PN des Cévennes	2.09.05	323,000	1984
Reserve nationale de Camargue BR	2.17.06	13,117	1977
Foret domaniale du Fango	2.17.06	6,410	1977
Atoll de Taiaro	5.04.13	2,000	1977
GABON			
Reserve naturelle integrale d'Ipassa-Makokou	3.02.01	15,000	1983
GERMAN DEMOCRATIC REPUBLIC			
Steckby-Loedderitz Forest Nature Reserve	2.11.05	2,113	1979
Vessertal Nature Reserve	2.11.05	1,384	1979
GERMANY, FEDERAL REPUBLIC OF			
Bayerischer Wald National Park	2.09.05	13,100	1981
GHANA			
Bia National Park	3.01.01	7,770	1983
GREECE/GRECE			
Gorge of Samaria National Park	2.17.06	4,840	1981
Mount Olympus National Park	2.17.06	4,000	1981
GUINEA/GUINEE			
Reserve de la biosphere du Massif du Ziama	3.01.01	116,170	1980
Reserve de la biosphere des Monts Nimba	3.01.01	17,130	1980
HONDURAS			
Rio Platano Biosphere Reserve	8.16.04	500,000	1980
HUNGARY/HONGRIE			
Hortobagy National Park	2.12.05	52,000	1979
Pilis Biosphere Reserve	2.11.05	23,000	1980
Kiskunsag Biosphere Reserve	2.12.05	22,095	1979
Biosphere Reserve of Aggtelek	2.12.05	19,246	1979
Lake Ferto Biosphere Reserve	2.12.05	12,542	1979
ILE MAURICE			
Voir paragraphe Mauritius			
INDONESIA/INDONESIE			
Gunung Leuser Reserves	4.21.13	946,400	1981
Tanjung Puting Nature Park	4.25.13	205,000	1977

Lore Lindu National Park	4.24.13	131,000	1977
Komodo National Park	4.23.13	30,000	1977
Siberut Nature Reserve	4.21.13	6,000	1981
Cibodas Reserve	4.22.13	1,040	1977
IRAN			
Touran Protected Area	2.24.08	1,000,000	1976
Kavir National Park	2.24.08	700,000	1976
Lake Oromeeh National Park	2.34.12	462,600	1976
Golestan National Park	2.34.12	125,895	1976
Hara Protected Area	2.20.08	85,686	1976
Miankaleh Protected Area	2.34.12	68,800	1976
Arjan Protected Area	2.34.12	65,750	1976
Arasbaran Protected Area	2.34.12	52,000	1976
Geno Protected Area	2.20.08	49,000	1976
IRELAND/IRELANDE			
Killarney National Park	2.08.05	8,308	1982
North Bull Island	2.08.05	500	1981
ITALY/ITALIE			
Foret Domaniale du Circeo	2.17.06	3,260	1977
Collemeluccio-Montedimezzo	2.32.12	478	1977
Miramare Marine Park	2.17.06	60	1979
IVORY COAST			
Parc national de la Comoe	3.04.04	1,150,000	1983
Parc national de la Comoe	3.04.04	1,150,000	1983
Parc national de Tai	3.01.01	330,000	1977
JAPAN/JAPON			
Mount Hakusan	2.02.02	48,000	1980
Mount Odaigahara & Mount Omine	2.02.02	36,000	1980
Yakushima Island	2.02.02	19,000	1980
Shiga Highland	2.15.05	13,000	1980
KENYA			
Mount Kulal Biosphere Reserve	3.14.07	700,000	1978
Mount Kenya Biosphere Reserve	3.21.12	71,759	1978
Kiunga Marine National Reserve	3.14.07	60,000	1980
Malindi-Watamu Biosphere Reserve	3.14.07	19,600	1979
KOREA, REPUBLIC OF			
Mount Sorak Biosphere Reserve	2.15.05	37,430	1982
MALI			
Parc national de la Boucle du Baoule (etc)	3.04.04	771,000	1982
MAURITIUS			
Macchabee/Bel Ombre Nature Reserve	3.25.13	3,594	1977
MEXICO/MEXIQUE			
Montes Azules	8.01.01	331,200	1979
Reserva de Mapimi	1.09.07	100,000	1977
Reserva de la Michilia	1.21.12	42,000	1977
NIGERIA			
Omo Reserve	3.01.01	460	1977

NORWAY/NORVEGE			
Northeast Svalbard Nature Reserve	2.25.09	1,555,000	1976
OUGANDA			
Voir paragraphe Uganda			
PAKISTAN			
Lalsohanra National Park	4.15.07	31,355	1977
PANAMA			
Darien National Park	8.02.01	575,000	1983
PERU/PEROU			
Reserva del Manu	8.05.01	1,881,200	1977
Reserva de Huascaran	8.37.12	399,239	1977
Reserva del Noroeste	8.19.04	226,300	1977
PHILIPPINES			
Puerto Galera Biosphere Reserve	4.26.13	23,525	1977
POLAND/POLOGNE			
Slowinski National Park	2.11.05	18,069	1976
Bialowieza National Park	2.11.05	5,069	1976
Babia Gora National Park	2.32.12	1,728	1976
Luknajno Lake Reserve	2.10.05	710	1976
PORTUGAL			
Paul do Boquilobo BR	2.16.06	395	1981
REPUBLIQUE CENTRAFRICAINE			
Voir paragraphe Central African Republic			
REPUBLIQUE DE COREE			
Voir paragraphe Korea, Republic Of			
REPUBLIQUE DEMOCRATIQUE D'ALLEMAGNE			
Voir paragraphe German Democratic Republic			
REPUBLIQUE-UNIE DU CAMEROUN			
Voir paragraphe Cameroon, United Republic of			
REPUBLIQUE-UNIE DU TANZANIE			
Voir paragraphe Tanzania, United Republic of			
ROMANIA/ROUMANIE			
Retezat National Park	2.11.05	20,000	1979
Rosca-Letea Reserve	2.29.11	18,145	1979
Pietrosu Mare Nature Reserve	2.11.05	3,068	1979
ROYAUME-UNI			
Voir paragraphe United Kingdom			
RWANDA			
Parc national des Volcans	3.20.12	15,065	1983
SENEGAL			
Parc national du Niokolo-Koba	3.04.04	913,000	1981
Delta du Sine Saloum	3.04.04	180,000	1980
Foret classee de Samba Dia	3.04.04	756	1979

SPAIN			
Las Sierras de Cazorla y Segura Biosphere Reserve	2.17.06	190,000	1983
Reserva de la Biosfera de Donana	2.17.06	77,260	1980
Reserva de Ordesa-Vinamala	2.16.06	51,396	1977
Reserva de Grazalema	2.17.06	32,210	1977
Reserva de la Biosfera de la Mancha Humeda	2.17.06	25,000	1980
Reserva de la Biosfera del Urdaibai	2.16.06	22,500	1984
Parque Natural del Montseny	2.17.06	17,372	1978
Reserva de la Biosfera de las Marismas del Odiel	2.17.06	8,728	1983
Reserva de la Biosfera del Canal y los Tiles	2.40.13	511	1983
SRI LANKA			
Sinharaja Forest Reserve	4.02.01	8,900	1978
Hurulu Forest Reserve	4.13.04	512	1977
SUDAN/SOUDAN			
Radom National Park	3.05.04	1,250,970	1979
Dinder National Park	3.13.07	650,000	1979
SWITZERLAND/SUISSE			
Parc national Suisse	2.32.12	16,870	1979
TANZANIA, UNITED REPUBLIC OF			
Serengeti NP & Ngorongoro CA	3.05.04	2,305,000	1981
Lake Manyara National Park	3.05.04	32,900	1981
TCHECOSLOVAQUIE			
Voir paragraphe Czechoslovakia			
THAILAND/THAILANDE			
Mae Sa-Kog Ma Reserve	4.10.04	14,200	1977
Sakaerat Environmental Research Station	4.10.04	7,200	1976
Hauy Tak Teak Reserve	4.10.04	4,700	1977
TUNISIA/TUNISIE			
Parc national de Djebel Bou-Hedma	2.28.11	11,625	1977
Parc national de l'Ichkeul	2.17.06	10,770	1977
Parc national de Djebel Chambi	2.28.11	6,000	1977
Parc national des Iles Zembra et Zembretta	2.17.06	4,030	1977
UKRAINIAN SOVIET SOCIALIST REPUBLIC/UKRAINE			
Tchernomorsky State Reserve	2.29.11	87,348	1984
Askania-Nova State Reserve	2.29.11	33,307	1984
UNITED KINGDOM			
Isle of Rhum National Nature Reserve	2.31.12	10,560	1976
Moor House-Upper Teesdale Biosphere Reserve	2.08.05	7,399	1976
Caerlaverock National Nature Reserve	2.08.05	5,501	1976
North Norfolk Coast Biosphere Reserve	2.08.05	5,497	1976
Beinn Eighe National Nature Reserve	2.31.12	4,800	1976
Silver Flowe-Merrick Kells Biosphere Reserve	2.08.05	3,088	1976
Cairnsmore of Fleet National Nature Reserve	2.08.05	1,922	1976
Loch Druidibeg National Nature Reserve	2.31.12	1,658	1976
Dyfi National Nature Reserve	2.08.05	1,589	1976
St Kilda National Nature Reserve	2.08.05	842	1976
Braunton Burrows National Nature Reserve	2.08.05	596	1976
Claish Moss National Nature Reserve	2.08.05	480	1977
Taynish National Nature Reserve	2.08.05	326	1977

UGANDA			
Queen Elizabeth National Park	3.05.04	220,000	1979
UNION OF SOVIET SOCIALIST REPUBLICS/UNION DES REPUBLIQUES SOCIALISTES SOVIETIQUES			
Kronotsky zapovednik	2.07.05	1,099,000	1984
Pechero-Ilychsky zapovednik	2.03.03	721,300	1984
Sayano-Shushensky zapovednik	2.04.03	389,600	1984
Sikhote-Alin Reserve	2.14.05	340,200	1978
Laplandsky zapovednik	2.27.09	278,400	1984
Caucasian Reserve	2.34.12	263,500	1978
Sokhondinsky zapovednik	2.04.03	211,000	1984
Astrakhansky zapovednik	2.21.08	63,400	1984
Repetek Reserve	2.21.08	34,600	1978
Voronezhsky zapovednik	2.11.05	31,053	1984
Sary-Chelek Reserve	2.36.12	23,868	1978
Central Forest zapovednik	2.10.05	21,348	1984
Priokosko-Terrasny Reserve	2.10.05	4,945	1978
Central-Chernozem Reserve	2.10.05	4,795	1978
UNITED STATES OF AMERICA			
Noatak Biosphere Reserve	1.13.09	3,035,200	1976
Mojave and Colorado Deserts Biosphere Reserve	1.08.07	1,292,704	1984
Aleutian Islands Biosphere Reserve	1.12.09	1,100,940	1976
Yellowstone National Park	1.19.12	898,349	1976
Denali National Park and Biosphere Reserve	1.03.03	782,000	1976
Everglades National Park (incl. Ft. Jefferson NM)	8.12.04	585,867	1976
South Atlantic Coastal Plain BR	1.5/6.05	444,335	1983
Glacier National Park	1.19.12	410,202	1976
Olympic National Park	1.02.02	363,379	1976
Sequoia-Kings Canyon National Parks	1.20.12	343,000	1976
Big Bend National Park	1.09.07	283,247	1976
Isle Royale National Park	1.22.14	215,740	1980
Great Smoky Mountains National Park	1.05.05	208,403	1976
Organ Pipe Cactus National Monument	1.08.07	133,278	1976
Beaver Creek Experimental Watershed	1.08.07	111,300	1976
Rocky Mountain National Park	1.19.12	106,710	1976
Hawaii Islands Biosphere Reserve	5.03.13	104,396	1980
Three Sisters Wilderness	1.20.12	80,900	1976
Jornada Experimental Range	1.09.07	78,297	1976
Central Gulf Coastal Plain Biosphere Reserve	1.06.05	72,964	1983
Big Thicket National Preserve	1.06.05	34,217	1981
Desert Experimental Range	1.11.08	22,513	1976
The Virginia Coast Reserve	1.05.05	13,511	1979
Luquillo Experimental Forest (Caribbean NF)	8.40.13	11,340	1976
Fraser Experimental Forest	1.19.12	9,328	1976
Channel Islands National Monument	1.07.06	7,448	1976
Cascade Head Expt. Forest & Scenic Research Area	1.02.02	7,051	1976
San Dimas Experimental Forest	1.07.06	6,947	1976
Central Plains Experimental Range (CPER)	1.18.11	6,210	1976
Virgin Islands National Park	8.41.13	6,127	1976
H.J. Andrews Experimental Forest	1.20.12	6,100	1976
California Coast Ranges Biosphere Reserve	1.02.02	5,624	1983
The University of Michigan Biological Station	1.18.11	4,048	1979
Guanica Commonwealth Forest Reserve	8.40.13	4,006	1981
Konza Prairie Research Natural Area	1.18.11	3,486	1979
Hubbard Brook Experimental Forest	1.05.05	3,076	1976
Coram Experimental Forest (incl. Coram NA)	1.19.12	3,019	1976

Coweeta Hydrologic Laboratory	1.05.05	2,185	1976
San Joaquin Experimental Range	1.07.06	1,832	1976
Niwot Ridge Biosphere Reserve	1.19.12	1,200	1979
Stanislaus-Tuolumne Experimental Forest	1.20.12	607	1976
URUGUAY			
Banados del Este	8.32.11	200,000	1976
YUGOSLAVIA/YUGOSLAVIE			
Reserve Ecologique du Bassin de la Riviere Tara	2.33.12	200,000	1976
The Velebit Mountain	2.33.12	150,000	1977
ZAIRE			
Reserve Floristique de Yangambi	3.02.01	250,000	1976
Forest Reserve of Luki	3.02.01	33,000	1979
Vallee de la Lufira	3.02.01	14,700	1982

Listing of Biosphere Reserves in the United States as of March 1, 1985

Name of Reserve	State	Biogeographic Province and Coastal Region (where applicable)	Administrators[1]	Area in Hectares	Management Emphasis[2]	Year Designated by UNESCO[3]	Misc[4]
Aleutian Islands		Aleutian Islands					
Alaska National Wildlife Refuge, Aleutian Islands Unit	AK	Aleutian Islands (Aleutian-North Pacific)	FWS	1,100,943	C(E)	1976	
Beaver Creek Experimental Watershed	AZ	Sonoran	FS	111,300	E	1979D	
Big Bend National Park	TX	Chihuahuan	NPS	283,247	C	1976D	
Big Thicket National Preserve	TX	Austroriparian	NPS	34,217	C	1981	
California Coast Ranges:		Oregonian					
Redwood National Park Unit	CA	Oregonian (Oregonian-Temperate Eastern Pacific)	NPS	31,570	C(E)	1983	
Jedediah Smith Redwoods State Park Unit	CA	Oregonian	State	3,720	C	1983	
Del Norte Coast Redwoods State Park Unit	CA	Oregonian (Oregonian-Temperate Eastern Pacific)	State	2,580	C	1983	
Prairie Creek Redwoods State Park Unit	CA	Oregonian (Oregonian-Temperate Eastern Pacific)	State	5,050	C	1983	
Redwood Experimental Forest Unit	CA	Oregonian	FS	380	E	1983	
Northern California Coast Range Preserve Unit	CA	Oregonian	TNC	1,568	C	1983	
Northern California Coast Range Preserve Research Natural Area Unit	CA	Oregonian	BLM	1,360	C	1983	

Listing of Biosphere Reserves in the United States as of March 1, 1985 (Continued)

Name of Reserve	State	Biogeographic Province and Coastal Region (where applicable)	Administrators[1]	Area in Hectares	Management Emphasis[2]	Year Designated by UNESCO[3]	Misc[4]
California Coast Ranges (Continued)							
Landels-Hill Big Creek Reserve Unit	CA	Oregonian (Oregonian-Temperate Eastern Pacific)	Univ.of CA	2,849	C	1983	
Western Slopes of Cone Peak Unit	CA	Oregonian	FS	6,475	C	1983	
Jackson Demonstration State Forest Unit	CA	Oregonian	State	20,452	C	1984	
Cascade Head Experimental Forest and Scenic Research Area	OR	Oregonian (Oregonian-Temperate Eastern Pacific)	FS	7,051	E	1976	IBP
Central Gulf Coastal Plain:		Austroriparian					
Lower Apalachicola River Basin Unit	FL	Austroriparian (Louisianan-Gulf of Mexico)	State	16,402	C	1983	
Central Plains Experimental Range	CO	Grasslands, short grass	ARS	6,210	E	1976	IBP
Channel Islands National Park	CA	Californian (Californian-Subtropical Eastern Pacific)	NPS	7,440	C	1976	
Coram Experimental Forest	MT	Rocky Mountains, north	FS	3,010	E	1976D	IBP
Coweeta Hydrological Laboratory and Experimental Forest	NC	Eastern Forest, south	FS	2,185	E	1976D	IBP LTER

Listing of Biosphere Reserves in the United States as of March 1, 1985 (Continued)

Name of Reserve	State	Biogeographic Province and Coastal Region (where applicable)	Administrators[1]	Area in Hectares	Management Emphasis[2]	Year Designated by UNESCO[3]	Misc[4]
Denali National Park	AK	Yukon Taiga	NPS	782,000	C	1976	
Desert Experimental Range	UT	Great Basin, south	FS	22,513	E	1976	IBP
Everglades National Park	FL	Everglades (Floridian-West Indian)	NPS	566,800	C	1976D	
Fraser Experimental Forest	CO	Rocky Mountains, south	FS	9,328	E	1976	
Glacier National Park	MT	Rocky Mountains, north	NPS	410,058	C	1976	
Great Smoky Mountains National Park	NC/TN	Eastern Forest, south	NPS	208,403	C	1976	
Guanica State Forest	PR	Greater Antillean	PR	4,000	C	1981	
H.J. Andrews Experimental Forest	OR	Sierra Nevada-Cascade, north	FS	6,100	E	1976	IBP LTER
Hawaiian Islands:		Hawaiian					
Haleakala National Park Unit	HI	Hawaiian (Insular-Indopacific)	NPS	11,462	C	1980D	
Hawaii Volcanoes National Park Unit	HI	Hawaiian (Insular-Indopacific)	NPS	92,934	C	1980D	
Hubbard Brook Experimental Forest	NH	Eastern Forest, north	FS	3,075	E	1976D	
Isle Royale National Park	MI	Eastern Forest/Canadian Taiga (Great Lakes)	NPS	54,144	C	1980D	
Jornada Experimental Range	NM	Chihuahuan	ARS	78,297	E	1976	IBD

Listing of Biosphere Reserves in the United States as of March 1, 1985 (Continued)

Name of Reserve	State	Biogeographic Province and Coastal Region (where applicable)	Administrators[1]	Area in Hectares	Management Emphasis[2]	Year Designated by UNESCO[3]	Misc[4]
Konza Prairie Research Natural Area	KS	Grasslands, true prairie	TNC	3,487	C(E)	1976D	LTER
Luquillo Experimental Forest	PR	Greater Antillean	FS	11,340	E(C)	1976D	
Mojave and Colorado Deserts		Sonoran					
Anza Borrego State Park	CA	Sonoran	State	222,585	C	1984	
Death Valley National Monument	CA	Sonoran	NPS	836,799	C	1984	
Joshua Tree National Monument	CA	Sonoran	NPS	226,609	C	1984	
Philip L. Boyd Deep Canyon Desert Research Center	CA	Sonoran	Univ. of California	6,711	C	1984	
Niwot Ridge	CO	Rocky Mountains, south	FS	1,200	C	1979	IBP LTER
Noatak		Alaskan Tundra					
Noatak National Preserve Unit	AK	Alaskan Tundra	NPS	3,035,200	C	1976	
Gates of the Arctic National Park Unit	AK	Alaskan Tundra	NPS	n/a	C	1984	
Olympic National Park	WA	Oregonian (Oregonian-Temperate Eastern Pacific)	NPS	363,379	C	1976	
Organ Pipe Cactus National Monument	AZ	Sonoran, typical	NPS	133,278	C	1976	

Listing of Biosphere Reserves in the United States as of March 1, 1985 (Continued)

Name of Reserve	State	Biogeographic Province and Coastal Region (where applicable)	Administrators[1]	Area in Hectares	Management Emphasis[2]	Year Designated by UNESCO[3]	Misc[4]
Rocky Mountain National Park	CO	Rocky Mountain, south	NPS	106,710	C	1976D	
San Dimas Experimental Forest	CA	Californian	FS	6,947	E	1976	
San Joaquin Experimental Range	CA	Californian	FS	1,832	E	1976	IBP
Sequoia-Kings Canyon National Park	CA	Sierra Nevada-Cascade, south	NPS	343,000	C	1976	
South Atlantic Coastal Plain:		Eastern Forest					
Pinelands National Reserve Unit	NJ	Eastern Forest, north (Virginian-Mid Atlantic)	Pinelands Commission	438,210	M	1983	
Congaree Swamp National Monument Unit	SC	Eastern Forest, south	NPS	6,125	C	1983	
Stanislaus-Tuolumne Experimental Forest	CA	Sierra Nevada-Cascade, south	FS	607	E	1976	
Three Sisters Wilderness	OR	Sierra Nevada-Cascade, north	FS	80,900	C	1976	IBP
University of Michigan Biological Station	MI	Eastern Forest, north central	Univ.of Michigan	4,048	C	1979	
Virgin Islands National Park	VI	Lesser Antillean (Floridian-West Indian)	NPS	6,130	C	1976D	
Virginia Coast Reserve	VA	Eastern Forest-north (Virginian-Mid Atlantic)	TNC	13,511	C	1979	
Yellowstone National Park	WY,MT,ID	Rocky Mountains, north	NPS	898,349	C	1976	

[1]Abbreviations:
ARS - Agricultural Research Service (U.S. Department of Agriculture)
BLM - Bureau of Land Management (U.S. Department of the Interior)
FS - Forest Service (U.S. Department of Agriculture)
FWS - U.S. Fish and Wildlife Service (U.S. Department of Agriculture)
NPS - National Park Service (U.S. Department of the Interior)
PR - Commonwealth of Puerto Rico
TNC - The Nature Conservancy

[2]Predominant management emphasis: C=conservation, E=experimental research, M=multiple use. Strong secondary emphasis indicated in parentheses.

[3]D=dedicated.

[4]IBP - Research site for International Biological Program, 1965-1975.
LTER - Pilot project site for Long-term Ecological Research Program of the National Science Foundation, 1980-.

DIRECTORY OF BIOSPHERE RESERVES IN THE UNITED STATES

Aleutian Islands

Alaska Maritime National Wildlife Refuge,
Aleutian Islands Unit
P.O. Box 5251
F.P.O.
Seattle, WA 98791
(907) 592-2406 or 2407

Beaver Creek Experimental Watershed
2323 Greenlaw Lane
Flagstaff, AZ 86001
(602) 527-7400 FTS 765-7400

Big Bend National Park
Big Bend National Park, TX 79834
(915) 477-2251

Big Thicket National Preserve
P.O. Box 7408
Beaumont, TX 77706
(713) 839-2691 FTS 527-2691

California Coast Ranges

Del Norte Coast Redwoods State Park Unit,
Jedediah Smith Redwoods State Park Unit, and
Prairie Creek Redwoods State Park Unit
c/o Fort Humboldt State Historic Park
3431 Fort Avenue
Eureka, CA 95501
(707) 443-4588

Jackson Demonstration State Forest Unit
P.O. Box 1185
Fort Bragg, CA 95437
(707) 964-5674

Landels-Hill Big Creek Reserve Unit
(University of California)
Big Sur, CA 93920
(408) 667-2543

California Coast Ranges (continued)

Northern California Coast Range Preserve Research Natural Area Unit
Bureau of Land Management
P.O. Box 940
555 Leslie Street
Ukiah, CA 95482
(707) 462-3873

Northern California Coast Range Preserve Unit
42101 Wilderness Road
Branscomb, CA 95417
(707) 984-6653

Redwood Experimental Forest Unit
Redwood Science Lab
1700 Bayview Drive
Arcata, CA 95521
(707) 822-3691 FTS 450-5318

Redwood National Park Unit
1111 2nd Street
Crescent City, CA 95531
(707) 464-6101

Western Slopes of Cone Peak Unit
Los Padres National Forest
42 Aero Camino
Goleta, CA 93117
(805) 968-1578 FTS 960-7578

Cascade Head Experimental Forest and Scenic Research Area
U.S.D.A., Forest Service
Forestry Science Laboratory
3200 Jefferson Way
Corvallis, OR 97331
(503) 757-4361 ext.4340 FTS 420-4429

Central Gulf Coastal Plain
Lower Apalachicola River Basin Unit
Apalachicola National Estuarine Sanctuary
57 Market Street
Apalachicola, FL 32320
(904) 653-8063

Central Plains Experimental Range
U.S.D.A., Agricultural Research Service
Crops Research Laboratory
Colorado State University
Fort Collins, CO 80523
(303) 484-8777   FTS 323-5227

Channel Islands National Park
1901 Spinnaker Drive
Ventura, CA 93001
(805) 644-8157

Coram Experimental Forest
Forestry Sciences Laboratory
Drawer G
Missoula, MT 59806
(406) 329-3533   FTS 585-3533

Coweeta Hydrologic Laboratory and Experimental Forest
999 Coweeta Lab Road
Otto, NC 28763
(704) 524-2128

Denali National Park
P.O. Box 9
McKinley Park, AK 99755
(907) 683-2294

Desert Experimental Range
Shrub Sciences Laboratory
735 North 500 East
Provo, UT 84601
(801) 377-5717   FTS 584-1014

Everglades National Park
P.O. Box 279
Homestead, FL 33030
(305) 247-6211   FTS 350-4653

Fraser Experimental Forest
U.S.D.A., Forest Service
Rocky Mountain Forest and Range Experiment Station
240 West Prospect Street
Fort Collins, CO 80526
(303) 221-4390, ext.250   FTS 323-1250

Glacier National Park
West Glacier, MT 59936
(406) 888-5441   FTS 585-5011

Great Smoky Mountains National Park
Gatlinburg, TN 37738
(615) 436-5615   FTS 222-3011

Guanica State Forest
Commonwealth of Puerto Rico
Department of Natural Resources
Box 5887
Puerta de Tierra, PR 00906
(809) 722-9284

H.J. Andrews Experimental Forest
U.S.D.A., Forest Service
Forestry Science Laboratory
3200 Jefferson Way
Corvallis, OR 97331
(503) 757-4395

Hawaiian Islands

Haleakala National Park Unit
P.O. Box 369
Makawao,
Maui, HI 96768
(808) 572-9177

Hawaii Volcanoes National Park Unit
P.O. Box 52
Hawaii Volcanoes National Park, HI 96718
(808) 967-7311

Hubbard Brook Experimental Forest
Box 27
Mirror Lake Road
West Thornton, NH 03284
(603) 726-8902   FTS 834-7011

Isle Royale National Park
87 North Ripley Street
Houghton, MI 49931
(906) 482-3310 FTS 226-6000

Jornada Experimental Range
U.S.D.A., Agricultural Research Service
P.O. Box 3 JER
New Mexico State University
Las Cruces, NM 88003
(505) 646-4842 FTS 571-8332

Konza Prairie Research Natural Area
Division of Biology
Kansas State University
Manhattan, KS 66506
(913) 532-6620 or 532-6615

Luquillo Experimental Forest
U.S.D.A., Forest Service
Institute of Tropical Forestry
P.O. Box AQ
Rio Piedras, PR 00928
(809) 763-3939

Mojave and Colorado Deserts

Anza Borrego Desert State Park Unit
P.O. Box 428
Borrego Springs, CA 90024
(714) 767-5311

Death Valley National Monument Unit
Death Valley, CA 92328
(619) 786-2331 FTS 688-2000

Joshua Tree National Monument Unit
74485 National Monument Drive
Twentynine Palms, CA 92277
(619) 367-7511

Philip L. Boyd Deep Canyon Desert Research Center Unit
(University of California)
P.O. Box 1738
Palm Desert, CA 92261
(619) 341-3655

Niwot Ridge
U.S.D.A., Forest Service
2995 Baseline
Boulder, CO 80303
(303) 444-6001 FTS 320-3437

Noatak

Noatak National Preserve Unit
P.O. Box 287
Kotzebue, AK 99752
(907) 442-3890 FTS 399-0150

Gates of the Arctic National Park Unit
P.O. Box 74680
Fairbanks, AK 99707
(907) 452-5363

Olympic National Park
600 East Park Avenue
Port Angeles, WA 98362
(206) 452-4501 FTS 396-4501

Organ Pipe Cactus National Monument
Route 1
Box 100
Ajo, AZ 85321
(602) 387-6849

Rocky Mountain National Park
Estes Park, CO 80517
(303) 586-2371

San Dimas Experimental Forest
U.S.D.A. Forest Service
Forest Fire Laboratory
4955 Canyon Crest Drive
Riverside, CA 93710
(714) 351-6555 FTS 796-6555

San Joaquin Experimental Range
U.S.D.A., Forest Service
Pacific Southwest Forest and Range Experiment Station
2081 East Sierra Avenue
Fresno, CA 93710
(209) 487-5588 FTS 467-5588

Sequoia and Kings Canyon National Parks
Three Rivers, CA 93271
(209) 565-3341

South Atlantic Coastal Plain

Congaree Swamp National Monument Unit
P.O. Box 11938
Columbia, SC 29211
(803) 765-5571 FTS 677-5571

Pinelands National Reserve Unit
The Pinelands Commission
P.O. Box 7
New Lisbon, NJ 08064
(609) 894-9432

Stanislaus-Tuolumne Experimental Forest
Pacific Southwest Forest and Range Experiment Station
2400 Washington Avenue
Redding, CA 96001
(916) 246-5225 FTS 450-5455

Three Sisters Wilderness
U.S.D.A., Forest Service
Willamette National Forest
P.O. Box 10607
Eugene, OR 97440
(503) 687-6521 FTS 425-6521

University of Michigan Biological Station
Pellston, MI 49769
(616) 539-8406 (June-August)
(313) 763-4461 (September-May; 4053 Natural Sciences Building, University of Michigan, Ann Arbor, MI 48109)

Virgin Islands National Park
P.O. Box 7789
Charlotte Amalie,
St. Thomas USVI 00801
(809) 775-2050

Virginia Coast Reserve
The Nature Conservancy
Brownsville
Nassawadox, VA 23413
(804) 442-3049

Yellowstone National Park
P.O. Box 168
Yellowstone National Park, WY 82190
(307) 344-7381 FTS 585-0372

TOTAL NUMBER OF BIOSPHERE RESERVES (1/85): 41

DATE DUE

IL: 2745106	
Larsen	
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U.S. DEPARTMENT OF THE INTERIOR

March 3, 1849

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environment and cultural value of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

U.S. DEPARTMENT OF THE INTERIOR
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ATLANTA, GEORGIA 30303